MAY 1926—THIRTY-SECOND YEAR

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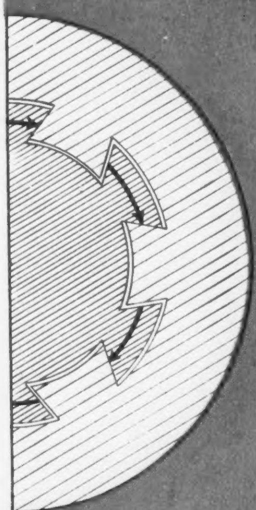

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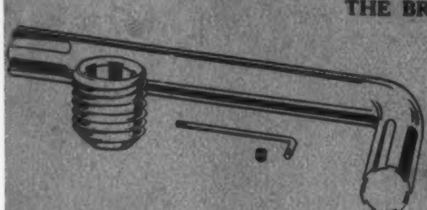

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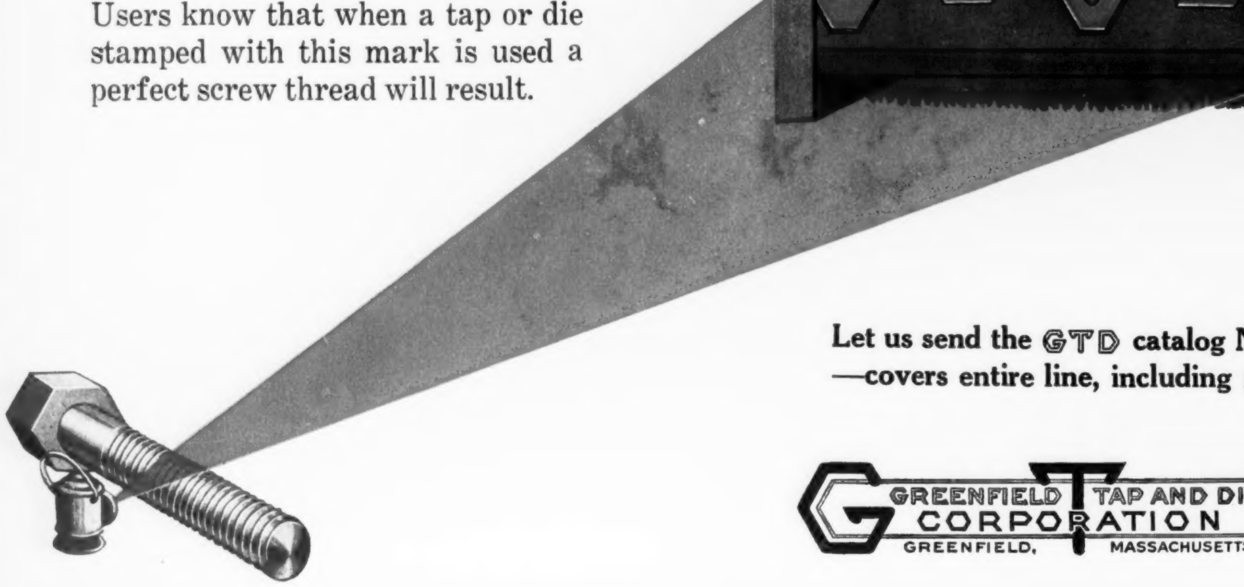

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MAY MACHINERY 1926

Accuracy Control in Interchangeable Manufacture

How the White Motor Co. Specifies Limits on Parts and Gages from Standardized Lists and Systematically Inspects All Gages

By CHARLES O. HERB

TRUE interchangeability of parts at the time of assembly into units or machines can be insured only if limits are intelligently specified on the parts and if these limits are strictly adhered to in the manufacturing processes. To meet these conditions, it is essential that there be a close tie-up between the engineering and manufacturing divisions, which will result in a united effort in the proper direction. At the plant of the White Motor Co., Cleveland, Ohio, such a tie-up is maintained through the functioning of a department of "Shop Engineering Standards," which has been in existence about two and one-half years. Briefly, the work of this department consists of assisting the engineering department in specifying limits, controlling the setting of limits on gages, and supervising the inspection of gages when they are received at the plant and periodically throughout their use. Many interesting facts relating to this system of limit and gage control will be brought out in this article.

Standardized Allowances and Tolerances

One of the first objects of the shop engineering standards department was to aid the engineering department in standardizing allowances and tolerances to be specified on parts for the various classes of fits. The unilateral system of tolerances that has been recommended by the American Engineering Standards Committee was adopted. In the unilateral system, the basic or nominal dimension of two mating parts is given to the "zero point," or point at which interference of metal begins. When both mating parts are finish-machined to size, the minimum size of all holes is

Fig. 1. Inspecting Diameter of Gages with "Supermicrometer"

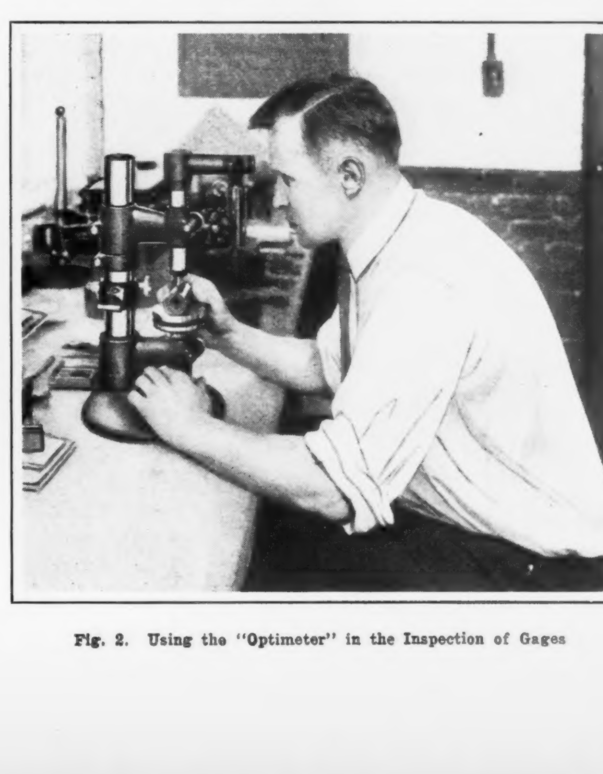

Fig. 2. Using the "Optimeter" in the Inspection of Gages

the standard basic dimension, regardless of the class of fit, and the tolerance is applied plus. The amount of clearance between the two parts is deducted from the basic dimension to obtain the maximum size of the shaft, and the shaft tolerance is applied minus. This rule applies to the greater bulk of work, but in cases where cold-drawn stock or stock purchased to size is used for the internal member, the maximum shaft size is the basic dimension, regardless of the class of fit. The amount of clearance between the two parts is added to the basic dimension to obtain the minimum hole size.

It was felt, and the White Motor Co. states that it has proved to be a fact, that the advantages of the unilateral system over the bilateral system of specifying tolerances include a greater degree of interchangeability of parts, a much smaller gage inventory, and the possibility of using standard size reamers and similar tools. Whenever it is necessary to change the design of a part, it is known that the basic nominal dimension is always to be zero point, whereas, in the bilateral system, the zero point changes with each class of fit. If a different tolerance must be specified on a part, there is approximately 75 per cent less drafting labor and 75 per cent less scrapping of gages when the unilateral system is in use. Also, there is less necessity for the hand-fitting of service parts.

Blueprint copies of the tables of limits and allowances recommended for the various classes of fits by the committee mentioned were made up for use in the engineering department and the factory. Thus, when new parts are drawn up, the proper limits to be specified on the operating surfaces can readily be determined from these tables. The blueprints also give definitions of all terms used in the inspection system, so as to educate the men concerning the correct usage of such terms as "tolerance," "allowance," and "limits," and thus avoid confusion. Limits are specified on all threaded parts according to Bulletin BIa of the American Engineering Standards Committee which relates to the American (National) screw thread system. Blueprint copies of the data contained in this bulletin have also been made up for use in the different departments. By reference to these lists, limits are now specified on work in an intelligent manner that insures strict interchangeability of parts.

Specifying Manufacturing Tolerances on Gages

All gages used in the White plant, with the exception of those made to meet emergencies, are purchased from gage manufacturers. To insure maximum life of the gages, certain wear allowances are required on their gaging surfaces, and when a gage is received at the plant, it is carefully inspected to make sure that the manufacturer has complied with the limits specified. Wear allowances for each type of gage have been standardized according to the manufacturing tolerance specified on the work for which the gages are intended, and according to the size of the work. It is desirable that the wear allowance of a gage be as great as possible, but it is also important that this allowance should not encroach too much on the manufacturing tolerance specified on the work; otherwise, the accuracy required of the work when the gage is new, may

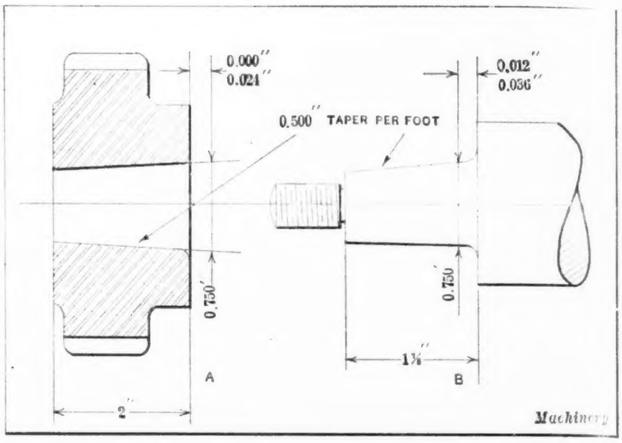

Fig. 4. Method of dimensioning Tapered Parts which insures the Correct Taper and Fit

be altogether impracticable. The various amounts of tolerance are given class symbols, and the tolerance class to which any gage belongs is stamped on that gage, together with its basic size.

On limit gages of the plug or snap type, the tolerance is applied in the direction toward the mean of the two limits, or plus on the minimum gage and minus on the maximum gage. On the "Go" member, an allowance is made for wear, which makes the actual limits to which the gage is made vary somewhat from the size stamped on it. For example, if the limits specified on a hole are 0.875 inch minimum and 0.880 inch maximum, giving a tolerance of 0.005 inch, the manufacturing tolerance given on the "Go" plug gage will be from plus 0.0005 to plus 0.0007 inch. This means that the minimum or "Go" plug gage may be anywhere between 0.8755 and 0.8757 inch in diameter, even though marked 0.875 inch.

In the case of maximum and minimum gages of the templet, length, or flush pin types the tolerance is applied in a direction to favor wear, and is made approximately 10 per cent of the total tolerance between the maximum and minimum limits of the work. The tolerance is applied minus on taper ring gages and plus on taper plug gages, to favor wear, on both the maximum and minimum gages.

On functional gages, the tolerance is applied in the same direction as on a "Go" gage of the same type, and is seldom closer than 0.0001 inch. On setting plugs and masters, the tolerance is applied in the same direction as on the gages that they are used for checking. In other words, maximum setting plugs have a minus tolerance, and minimum setting plugs, a plus tolerance.

Much of the foregoing information relative to the specifying of limits on gages has been embodied in a set of instructions drawn up for the use of gage inspectors in the shop and to acquaint the gage manufacturers with the gaging practice of the White Motor Co. These instructions also contain data to be given in the following, concerning the classification, hardness, temperature of checking, required finish, and marking of gages.

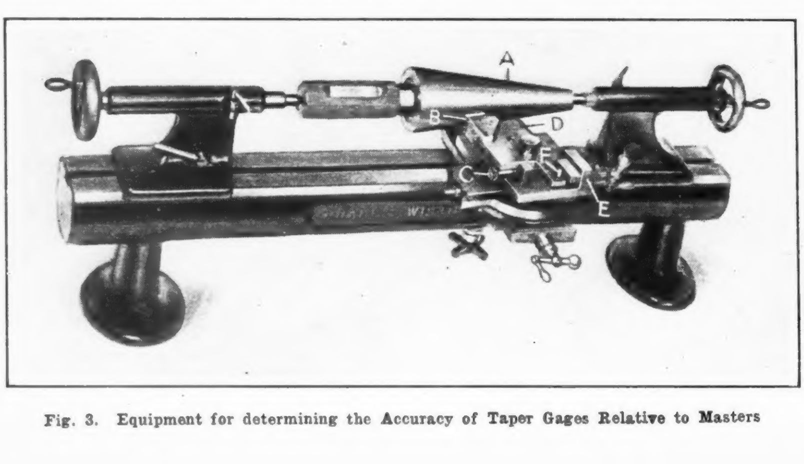

Fig. 3. Equipment for determining the Accuracy of Taper Gages Relative to Masters

Classification of Gages

All gages used in the White plant are included in one of the following classes, depending upon the use to which the gage is put.

Master Gages—These gages are used only as checks for inspection or working gages. The master for a ring gage is a plug, and the master for a plug gage is usually another plug from which a measurement may be taken for comparison. A basic size gage is also known as a "master" and is marked "master reference."

Setting Gages—Setting gages are used where an adjustable gage requires a stand-

ard to which it may be set. For example, an adjustable thread ring or thread snap gage requires a setting gage of the plug type.

Inspection Gages—Gages of this class are used by the inspector to check work coming either from the factory or from outside sources.

Rough Inspection Gages—These gages are used by the receiving inspection department in checking rough castings, forgings, etc., to ascertain whether enough metal is left for finishing the parts. The tolerances on these gages are wide.

Working Gages—Working gages are used by the machine operators for checking the work as it comes from the machine, either in a semi-finished or finished state. They are made to a tolerance within the inspection gage tolerance, or larger than the minimum dimension of the work and smaller than the maximum dimension.

Functional Gages—Functional gages are used to test the functional relation of two such mating parts as a spline shaft and a hole. A functional ring gage must provide a clearance between itself and the maximum piece to be tested equal to 40 per cent of the minimum clearance between the mating parts. A functional plug gage must provide a clearance between itself and the minimum piece equal to 40 per cent of the minimum clearance between the mating parts.

Material Hardness and Finish of Gages

Unless otherwise specified, the gaging surfaces of all gages are made of a good grade of gage steel, hardened and seasoned. Templet, profile, and length gages of the flat type up to 6 inches long are made of tool steel, with the gaging surfaces hardened and seasoned. When more than 6 inches long, such gages may be made of a good grade of machine steel or cold-rolled steel, or equivalent, and the gaging surfaces pack-hardened. Generally speaking, the hardness of gaging surfaces should be such as to resist cutting with a No. 2 Swiss file.

Accurate measurements of gages are made in a room temperature of 68 degrees F. When the manufacturing tolerance specified on a gage is 0.0002 inch or less, the gaging surfaces must be lapped, and preferably machine lapped. In cases where a greater tolerance is required, a high grade ground finish is acceptable. All sharp corners must be broken unless otherwise specified.

Gage manufacturers are required to mark the following data on all gages: Gage number; manufacturer's name or mark; kind of steel used; date made, except on gages having replaceable gaging members; the word "Go" with the corresponding dimension, and the words "No Go" with the corresponding dimension, on the respective types; a symbol indicating the use for which the gage is intended, whether it is an inspection or working gage, etc.; and the tolerance class to which the gage belongs, as determined by the difference between the "Go" and the "No Go" gage ends. In addition to this information, the nominal size, pitch of thread, and class of fit must be marked on thread gages.

All replaceable gage ends are marked by the manufacturer with the word "Go" and the "Go" dimension, or the words "No Go" and the corresponding dimension, together with the tolerance class to which the gage belongs and the identification mark of the manufacturer. If the member is reversible, the marking is placed on both ends, and if not reversible, it is placed on the exposed end only.

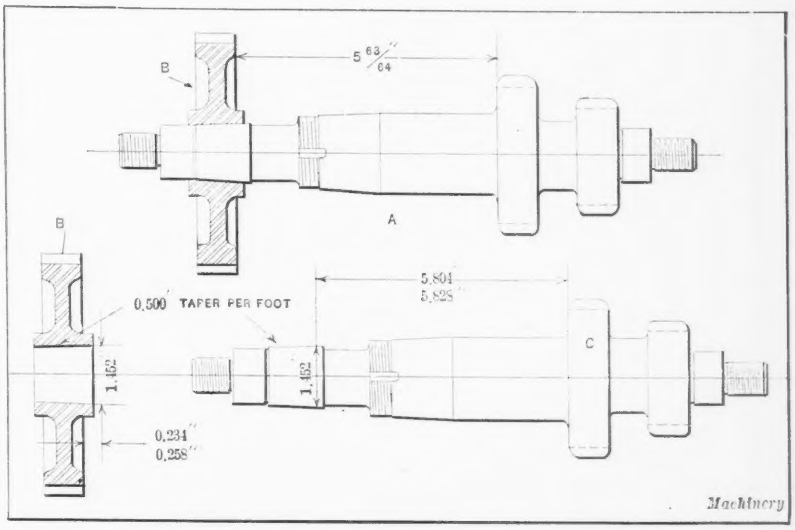

Fig. 6. Another Example of the Application of the Taper Dimensioning Method when the Assembled Part does not come in Contact with a Shoulder

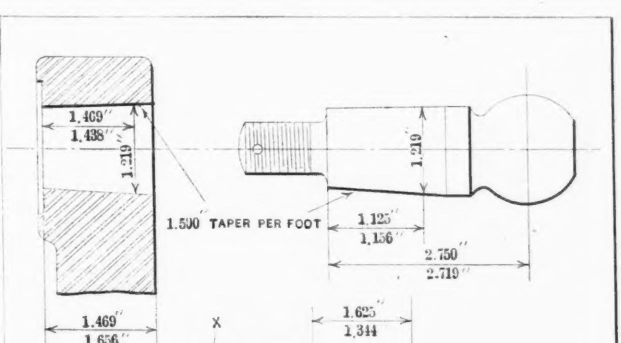

Fig. 5. Illustration showing how the Method of dimensioning Tapers is applied when a Definite Amount of Space must be allowed for Lengthwise Adjustment

The Inspection of Gages

When a gage is received at the plant, it is sent to the gage inspection department shown in the heading illustration, where it is checked to make certain that the manufacturer has produced the gage within the specified limits as indicated by the tolerance class symbol marked on the gage. For this work, the department is supplied with high-grade inspection equipment, including several sets of Johansson gage-blocks, in one of which the blocks are accurate within two-millionths of an inch. Altogether, there are seven sets of these gage-blocks in the inspection department and tool-room.

The majority of gages of the male type which have comparatively wide tolerances are inspected on a "Supermicrometer," but when the tolerance is close, the gages are checked on an "Optimeter." The hardness of surfaces is determined by means of a scleroscope, equipped with a dial on which the reading remains until the next test is made. A toolmaker's microscope is used a great deal in the inspection of thread gages. For inspecting the gage-blocks from time to time, a light wave equipment based on the interferometer principle is employed. Flat surfaces can be measured accurately by means of this equipment within one hundred-thousandth of an inch, and even closer by interpolation.

Taper gages are inspected by means of the taper comparator illustrated in Fig. 3, in which the gage is held between centers, as shown at *A*. For each taper gage there are two masters, an inspection master and a working master. The working master is sent to the gage manufacturer whenever a gage of the same size is ordered, so that the gage can be made from it. The inspection master never leaves the gage inspecting department, and is used solely for checking purposes, as will be explained.

When the taper of a gage is to be inspected, the corresponding master is placed in the taper comparator and then the various adjustments of the carriage and compound rest are manipulated to align the hardened block *B* approximately with the taper surface. The carriage is next locked to the bed of the comparator, after which close alignment of block *B* with the taper is accomplished by turning screw *C*, which swivels part *D* to which block *B* is attached. Gage-blocks are then slipped between lug *E* and pin *F* to determine the exact distance between these two members.

The master is next removed from the machine and replaced by the gage, without loosening the carriage, and then block *B* is aligned with the taper of the gage in the same manner as when the master was used. Gage-blocks are again slipped between lug *E* and pin *F* when block *B* is in contact with the gage, and the size of the block is compared with the size of the block used in connection with the master. By this means it is easy to determine the exact amount of variation between the angle of taper on the gage and on the master, since a difference of 0.0001 inch in the thickness of the gage-blocks indicates a difference of 5 seconds on the taper of the gage.

Periodical Inspection of Gages in Use

In order to prevent spoiled work in the shop, due to the use of gages worn under or over size, all gages are checked periodically by field inspectors, who withdraw the gages as they become worn to the maximum or minimum size. One of these field inspectors visits each departmental tool-crib every day, and while he is at the crib a red electric light is turned on to inform the various gage users in the department that gages kept in constant use, micrometers, etc., are to be brought to the tool-crib for checking. After a gage has been measured, the inspector can readily determine from observing the tolerance class marked on it and referring to his chart of tolerances, whether or not the gage has worn beyond the limits. No exercise of judgment is left to the individual inspector as to whether the gage is sufficiently worn to warrant scrapping. His law is the tolerance chart, and when the gage is found to be worn "below the line" it is immediately removed from service and replaced by a new one from stock. This practice tends to eliminate arguments between the inspector and the operator, besides maintaining accurate production.

Gages returned to the tool-crib in the interval between the visits of the field inspector, are placed on a bench and are not stowed away until they have been marked with Prussian blue to indicate that they have passed inspection. A field inspector's equipment consists of a set of Johansson gage-blocks and accessories, a set of master micrometers, an optical flat for checking the parallelism of micrometer anvils and similar surfaces, and a chart showing the wear limits of the different classes of gages.

Dimensioning Tapers to Insure Accurate Fits

In addition to controlling the specifying of limits on work and gages and the use of gages, as outlined, the shop engineering standards department also gives considerable thought to standardizing methods of expressing dimensions on drawings. One of the biggest problems was to determine upon an efficient method of dimensioning tapers, and the department has adopted a system that always insures the desired fit of taper, and permits a convenient determination of the amount that two mating parts can be drawn together before a tight fit occurs. This method of dimensioning is worth a description here.

In general, a flat basic dimension (without a tolerance) is given for a taper diameter and located by means of a dimension (with a tolerance) from some pertinent, fixed point. For instance, at *B* in Fig. 4, a diameter of 0.750 inch is specified at a distance of from 0.012 to 0.036 inch from the shoulder, and the taper is given as 0.500 inch per foot. On the mating gear, the 0.750 inch diameter may vary from 0.000 to 0.024 inch from the hub. By adding the linear tolerances of the two mating parts, it will be obvious that the parts can be drawn together from 0.012 to 0.060 inch (which is equivalent to an interference of from 0.0005 to 0.0025 inch on the diameter) before the hub of the gear comes in contact with the shoulder of the shaft.

This method of dimensioning is based on the principle that the basic dimension will occur somewhere on the taper seat, and it is this point that locates the relative seating of the two mating parts. The basic dimension should be identical on both mating parts, and must be located from the surface that is most vital in the final assembly, or from a surface that is available during machining. In the examples here given, the dimensions used are purely arbitrary, and should not be taken to indicate recommended fits. Each problem requires special consideration.

In the example illustrated in Fig. 5, the important point is to have a certain amount of clearance *X* at the small end of the taper surfaces, to permit lengthwise adjustment of the stud for wear. By comparing the limits specified for the position of the 1.219-inch dimension on the stud and hole, it will be found that the minimum clearance *X* will be 9/32 inch, and the maximum clearance 11/32 inch.

When a tapered part is not to come in contact with a shoulder when mounted on another part, an assembly drawing, such as illustrated at *A*, Fig. 6, is required to show the correct assembly. It will be noted, by comparing the limits on the shaft *C* and gear *B*, that the hub of the assembled gear *B* will be located from 6.038 to 6.086 inches from the integral gear *C* of the shaft when gear *B* and the shaft are brought into metal-to-metal contact. By comparing these two dimensions with the 5 63/64 (or 5.984) dimension given in the assembled view, it will be found that a draw of from 0.054 to 0.102 inch (equivalent to from 0.0023 to 0.0043 inch of diametrical interference, respectively, on a 24 to 1 taper) is possible before the parts are pressed to the desired fit.

* * *

ANNUAL MEETING OF WELDING SOCIETY

The annual meeting of the American Welding Society was held in the Engineering Societies Building, New York City, April 21 to 23. Among the features, was a meeting of the gas welding committee under the chairmanship of S. W. Miller, at which a review of the progress made by the various subcommittees was presented, including those on material for welding, welds subjected to high temperature, and training of operators. The electric arc welding committee, under the chairmanship of H. M. Hobart, discussed reports of the subcommittees on non-ferrous metals and on fundamentals of arc welding. A large number of additional tests have been made during the past year on welded specimens, to determine the effect of such factors as current, size of electrodes, design of joints, positions of welding, etc. Consideration was also given to the possibilities of a scientific investigation on the fundamentals of arc welding, including a review of welding under hydrogen atmosphere.

Papers were read on the following subjects during the various sessions of the meeting: "Design of Welded Equipment for Chemical Plants," by H. D. Edwards, works manager, Carbide and Carbon Chemical Corporation; "Design of Joints in Piping Installations," by L. J. Sforzini; "Design of Joints in Ship Construction," by J. W. Owens, director of welding, Newport News Shipbuilding and Dry Dock Co.; "Design of Welded Joints, with Special Reference to Pressure Vessels," by S. W. Miller, consulting engineer, Union Carbide and Carbon Research Laboratories; "The Design of an Arc-welded Pressure Vessel," by L. H. Burkhart, chief engineer, Struthers-Wells Co.; and "Design of Welded Joints for Tanks and Containers," by A. C. Vick, engineering department, Detroit Range, Boiler & Steel Barrel Co.

Friday morning, April 23, a meeting was held in conjunction with the American Bureau of Welding, at which well-known men identified with the welding field gave five-minute talks suggesting research problems and indicating how these problems might be solved. In the afternoon of the same day, an inspection trip was arranged to the Metal and Thermit Corporation's plant in Jersey City, N. J.

Stelliting Metal Parts

A New Process of Applying Stellite to Metal Surfaces which are Called Upon to Withstand Heat, Abrasion or Corrosion

UP to the present time, the most important application of stellite has been in making metal-cutting tools. However, stellite possesses properties that make it desirable for parts subjected to heat, abrasion, or corrosion, and the reasons why it has not been more generally used in making such parts are the difficulty of fabrication and the large amount required when the entire parts are cast from this metal. Hence, it is interesting to learn that the Haynes Stellite Co., Kokomo, Ind., has recently developed a method of depositing stellite on metal surfaces subjected to wear. The process is termed "stelliting."

Stelliting is accomplished by simply flowing melted stellite rod on a metal surface which has previously been cleaned and preheated. It is preferable to use the oxy-acetylene blow-pipe in the operation, but it is also possible to use the electric carbon arc. Any grade of straight or alloy steel may be stellited, as well as cast iron, semi-steel, and malleable iron. Copper may also be stellited by a process differing in some respects from the one to be described in this article.

The new process effects economies in that it enables parts to be salvaged that have worn to such an extent that they would ordinarily have to be discarded. The building up of the worn surfaces and grinding them to the original size can be done at a nominal cost. A second economy, and the major one, is the increase in life imparted to the steel by stelliting the worn surfaces, it being claimed that stellited surfaces have outlasted the original steel surfaces from three to thirty times, depending upon the use of the parts. When stellited parts are worn under size, they can be easily built up again.

Characteristics of the Operation

Stellite rods 1/4 inch in diameter should be used when the surface to be stellited is of small area or the parent metal is of thin section. With heavier parts or large surfaces, 5/16-inch rods may be used. The melting point of ordinary stellite rod is about 2335 degrees F., which is quite close to the melting point of cast iron and steel. This is an important point in the stelliting operation, as both the stellite and the base metal are brought to a state of fusion by the oxy-acetylene flame. The similar melting points insure a strong and properly alloyed bond between the stellite and the base metal.

To stellite a surface successfully, it is necessary to avoid blow-holes on or beneath the stellite coating and checks or surface cracks caused by uneven cooling. Thorough preheating and annealing of the base metal is essential to the successful application of the process, because even though the melting points of steel and stellite, and the coefficients of linear expansion, are approximately the same, stellite changes from the liquid to the solid state more quickly than steel when both are cooled in air. Therefore, unless the steel is preheated evenly, kept up to heat during the operation, and cooled slowly, internal strains will be set up that are great enough to check the stellited surface. Preheating also facilitates the stelliting operation and the quick removal of scale.

Stelliting is not welding, since the operation differs from any other performance with the blow-pipe. The flame should be almost parallel to the surface being stellited, and two or three inches of the rod should be enveloped by the flame. This will keep the rod hot, so that when the base metal just begins to "sweat," the stellite can be flowed on quickly. Fig. 1 shows the correct method of holding the blow-pipe and rod in stelliting flat surfaces, and Fig. 2 shows how they are held in stelliting small irregular surfaces. The horizontal flame lessens the possibility of heating too deeply into the base metal and forming a "crater" which would cause trouble in obtaining a stellite surface free from blow-holes or iron alloy. The only other precaution to be emphasized is that all scale, dirt, and foreign material must be removed from the surface before the stellite is applied. Such material will cause blow-holes that will render the stellited part unfit for

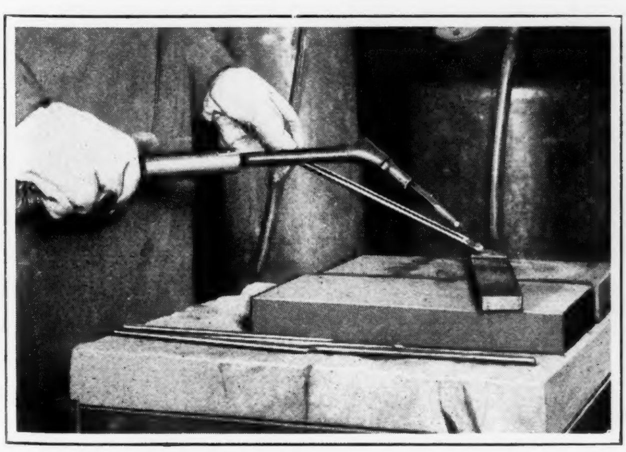

Fig. 1. Correct Method of holding the Blow-pipe and Stellite Rod in stelliting Flat Surfaces

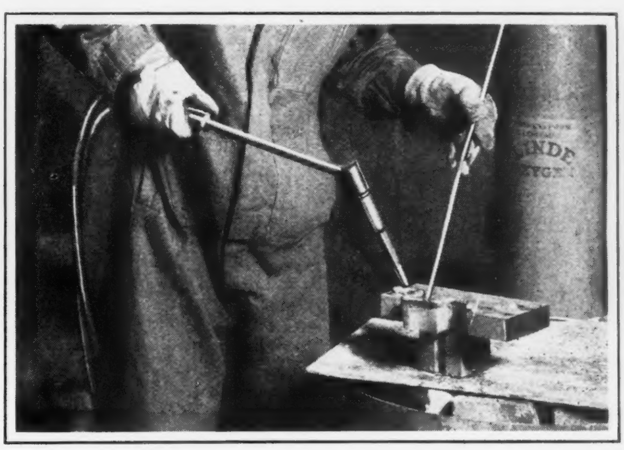

Fig. 2. Proper Method of holding the Blow-pipe and Rod in stelliting Small Irregular Surfaces

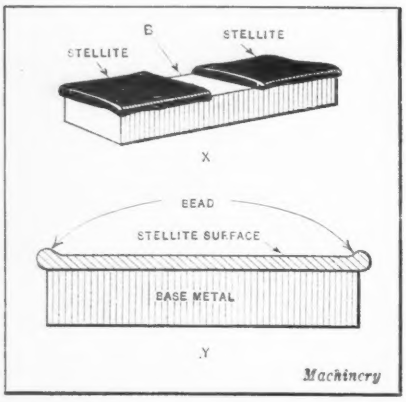

Fig. 3. Diagram illustrating Certain Points to be observed in stelliting

most purposes. Speed is essential in the stelliting operation.

All oxide, scale, or other foreign substances should be removed by grinding from the surface to be stellited. If grinding facilities are not available, the surface may be cleaned with a file or wire brush, but this method often leaves scale and other material which must be floated during the stelliting. When the pieces are of such design that the area to be cleaned is inaccessible for grinding, a flux may be used just before stelliting, as will be explained later. When the stelliting consists of building up a die corner, the corner should be beveled to a cup shape, as shown at the top of the part illustrated at the extreme right in Fig. 4. This design facilitates the stelliting and gives a joint of maximum strength. Fig. 4 shows (from left to right) a new steel hammer, a stellited hammer before grinding, a ground stellited hammer, and a ground stellited hammer after 92 hours of use. The ordinary steel hammer lasted 14 hours on the same class of work.

The piece should be lined up in much the same way for stelliting as in cast-iron welding, with the area to be stellited aligned approximately horizontal and supported in such a way as to prevent warpage. If the piece is of such a nature

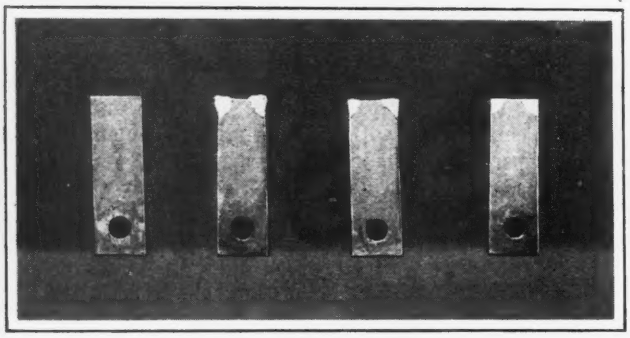

Fig. 4. Plain Steel Hammer Part and Stellited Parts before and after grinding

that it cannot be stellited in a single setting, care should be taken to assure the conditions of alignment in each setting.

Preheating the Work and Character of Flame

After the surface of the piece has been cleaned, the preheating should be performed either by means of a temporary or permanent furnace, a gas torch or blow-pipe, depending entirely upon the size and shape of the piece. It should be slowly and evenly brought up to a temperature of about 1200 degrees F., and it is essential that this temperature be reached before the operation is started. When preheating with a blow-pipe, a neutral flame should be used.

The piece should be maintained at an even heat throughout the stelliting operation, and at the approximate temperature arrived at in preheating. Any opening in the furnace, other than that necessary for exposing the surface being stellited, should be covered with asbestos or other insulating material. When the piece is removed from the furnace during the operation, it should be covered as much as possible with asbestos to protect it from draughts and uneven cooling.

A reducing flame should be used, with the flare, or outer cone, denoting an excess of acetylene by extending double the length of the inner cone. It will be found that the inner cone lengthens slightly and becomes less perceptible as the acetylene is increased, but the proper proportions of the two cones may be easily determined after a little practice. When too little acetylene is used, blow-holes will be formed because of the puddle foaming and bubbling due to the oxidation or burning of some constituents of the stellite. On the other hand, too much acetylene will be evidenced by an excessive coating of carbon around the puddle. This flame will reduce the speed of the operation, but it is preferable to a flame containing insufficient acetylene.

When the surface to be built up is of small area, it may be given a preliminary coating across the entire surface at

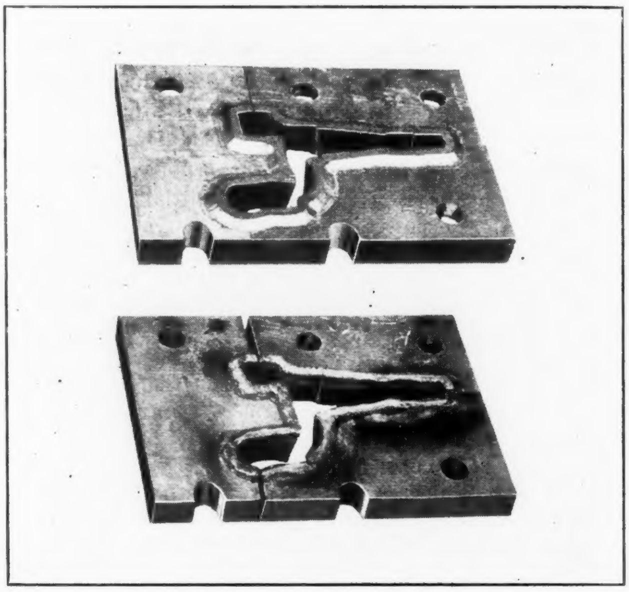

Fig. 5. Steering Knuckle Trimming Dies before and after stelliting

one time. The flame should be played on a small area in one corner of the piece until the temperature is elevated to a point where the carbon coating deposited by the reducing flame disappears and the base metal begins to sweat. The rod should be brought to the fusion point at the same time by immersing it in the blow-pipe flame. A drop of stellite should then be allowed to fall and fuse with the sweating base metal. If this stellite gathers in a ball, as a drop of water will on an oily surface, it indicates that the parent metal has not been brought to the proper stelliting temperature. This condition must be remedied before adding more stellite. The stellite should flow into and fuse readily with the base metal.

In coating the remaining surface, the blow-pipe flame should be kept ahead of the melted pool of stellite in order

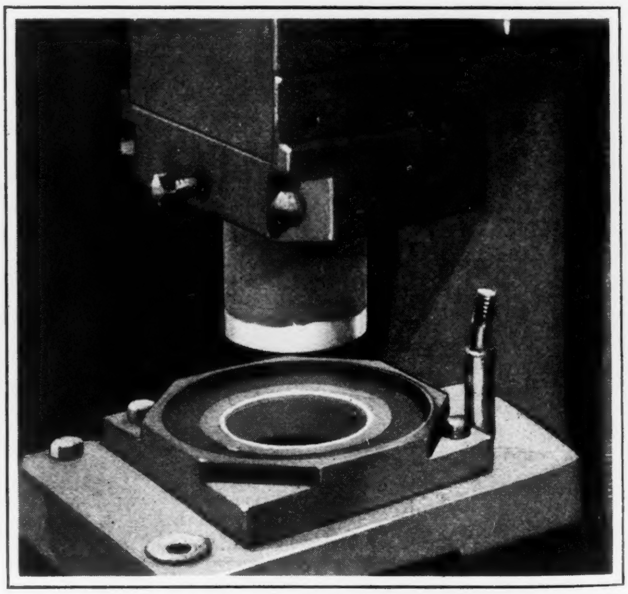

Fig. 6. Power Press Punch and Die which have been stellited on the Surfaces subjected to Wear

to bring the parent metal up to the proper fusing temperature. As the work progresses, the rod should be kept in the molten puddle, but agitated as little as possible to obviate digging it into the parent metal. If the parent metal is brought to the fusion point before the stellite is flowed on it, the stellite will run under scale or other impurities and float them. However, if the metal surrounding the impurities has not been brought to the molten state, the stellite will cover the scale and form blow-holes. The method of removing scale is similar to the removal of sand in welding cast iron, the flame being played on the surrounding metal until the impurity floats. If the design of the piece is such that it cannot be ground in order to remove the scale, a good grade of brazing flux may be used to help float the scale before coating, but the flux should be used sparingly and only when necessary.

An effort should be made to melt as thinly into the parent metal as possible in order to minimize the thickness of the layer in which the parent metal alloys with the stellite. In coating cast iron, more of the parent metal must be fused, because of the porous structure and characteristic action when subjected to the blow-pipe flame. When the section to be stellited is of such an area that the operations of coating and building up cannot be accomplished without a rest interval on the part of the operator, only that portion should be coated which can be built up to the required height before a rest period is taken.

Building up Stellite on Stellite

After the surface of the part has been coated without blow-holes or other defects, it may be built up to the required dimensions. This operation consists of adding stellite to stellite, and is comparatively simple, provided the proper procedure has been followed in the preliminary coating. One corner of the coated surface should be brought up to the fusion point, which will be indicated by an oily appearance, and then the filler rod added as before. Care should be taken to confine the stellite puddle to the enveloping cone so as to prevent oxidation. In stelliting cast iron, a heavy top layer of stellite must be added to insure a surface of pure metal.

Stellited surfaces cannot be bent or hammered back into shape if warpage of the piece occurs. For this reason, if the piece to be stellited should have a tendency to warp when built up in one operation, the coating and building up should be done in sections so as to compensate for this effect. By first stelliting a section at each end of the piece, as shown at *X* in Fig. 3, the piece may be straightened before section *B* is built up.

Whenever stelliting is done in sectional blocks, the sides of the surfaces to which another block is to be fused should be left with a rounded edge or bead, as indicated at *Y* in Fig. 3, so as to permit proper fusion of the parent metal and stellited block. Stellite is nearly as fluid as cast iron, and when it is necessary to build up a square corner, the same general practice should be followed as in welding cast iron. This may be done by reducing the size of the blow-pipe flame and building up rounded corners as shown. By later grinding down the rounded corners, square corners can be obtained. In stelliting a large area, it is advisable to build it up in sectional blocks rather than to attempt to stellite the entire area in one operation.

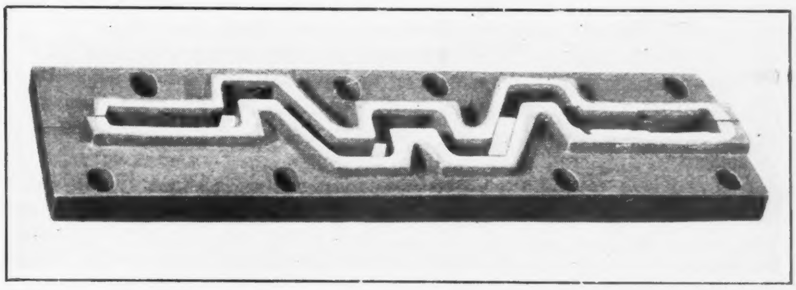

Fig. 8. Typical Crankshaft Trimming Die with the Cutting Edges stellited

Annealing Stellited Parts

After the completion of the stelliting operation, the piece should be reheated until there is an even temperature throughout, and then cooled slowly and evenly in an annealing bin or furnace. If the piece has been stellited in a temporary fire-brick furnace, the annealing may be accomplished by adding sufficient charcoal to obtain the desired reheating effect. All openings in the furnace should be covered with asbestos paper, and the piece allowed to remain in the furnace until completely cooled.

If the piece was removed from the preheating furnace for stelliting, it should be returned to the furnace for reheating, and then placed in a specially constructed annealing bin and covered up. Slow and even cooling of the piece is essential.

When inspection after grinding reveals a blow-hole in the stellited surface, the stellite should be melted around the blow-hole until the scale or other impurity causing the flaw has been floated to the surface. When checks are in evidence, the stellite should be melted until the fine white line which shows up under the heat from the blow-pipe has been eliminated. The metal may then be allowed to run together, and stellite added to bring the surface to the required height.

Typical Applications of the Process

The most important application of stelliting in the metal-working field has been in making and salvaging dies for hot or cold bending, shearing, forming, blanking, stamping, drawing, and trimming. Hitherto, only simple dies could be made from stellite, as the metal can only be machined by grinding. Also, dies made from solid stellite could be used for light work only, as such castings lack the strength essential for heavy work.

Fig. 5 shows two views of a die used in hot-trimming automobile steering knuckle forgings. The upper view shows the manner in which the three die parts were ground prior to stelliting, and the lower view, the appearance of the parts after they were stellited, but before being finish-ground. On such parts it is seldom necessary to grind off more than 0.030 inch of stellite to finish the surfaces. Fig. 6 shows a punch and die for a power press. It can readily be seen that the wearing surfaces of these two parts have been stellited. In Fig. 7 are shown two views of an axle forging die stellited along the wearing edges. The upper view shows the appearance of the stellite before the finish-grinding, and the lower view, the appearance after the grinding has been accomplished.

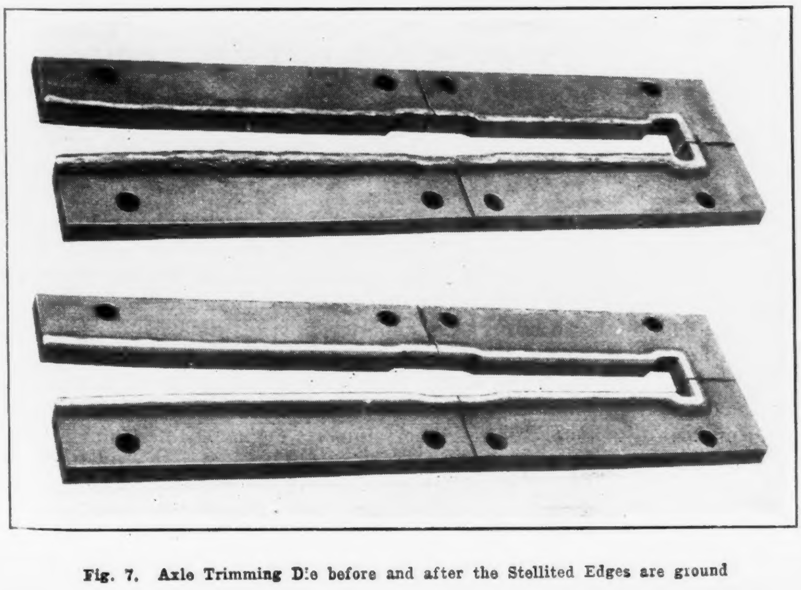

Fig. 7. Axle Trimming Die before and after the Stellited Edges are ground

In the manufacture of automobile crankshafts, the flash is trimmed off in a heavy press while the piece is still hot. The best steel dies average 800 crankshafts in this operation per grinding, whereas an old die reclaimed by stelliting finished 4448 crankshafts before regrinding was necessary. This constituted not only a gain of 500 per cent in the life of the die, but also a material reduction in the idle time of the trimming press, and incidentally, a corresponding increase in production. In the same plant, and on the same class of work, where flash as wide as 1/4 inch had to be trimmed from the work, a stellited die trimmed 6164 crankshafts per grinding, as against 400 pieces for a steel die.

The die illustrated in Fig. 8 is one employed for trimming crankshafts. It is 30 inches long, and the cutting edge on each side is 52 inches long. When made of the best chrome-nickel steel, this die would produce about 4000 pieces before scrapping was necessary, whereas a stellited die yields an average of 10,000 crankshafts. The original cost of a steel die is $500, and it can be stellited for about $50 to last two and one-half times longer than the original die.

Stellite to a thickness of about 1/8 inch was deposited on the wearing surfaces of a ring die used in shearing and drawing sheet metal 1/32 inch thick. After being stellited, this die produced 200,000 pieces before regrinding was necessary, as compared with 40,000 pieces from the original steel die. When the die had been reground six times and again worn, it had to be discarded, whereas the die can now be reclaimed indefinitely by stelliting.

In hot-forming spring clips to shape after forging, an exceptionally good steel die would last for 1000 pieces. An old die salvaged by stelliting produced 25,000 pieces before wear became noticeable. In cold-forming operations on pieces made from steel strips, 1/4 inch thick, steel dies have produced 40,000 pieces by regrinding the forming edges three times. These dies cost about $100 each, and each regrinding $15, giving a total die cost of $145 for the 40,000 pieces. An old die stellited at a cost of about $100 has produced 800,000 pieces per grinding, and can be reground three times. It can, of course, be restellited indefinitely.

Machinery of many classes contains cams, trips, guides, and other parts subjected to considerable wear. Such parts can be stellited to increase their life. There have also been numerous applications of the process in the cement and other industries employing crushing and pulverizing equipment. In the oil fields, drilling tools have been stellited to increase their efficiency.

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MACHINERY MARKET IN BRAZIL

Rio de Janeiro, the federal capital and financial center of Brazil, leads in the importation of industrial machinery, and here, according to *Commerce Reports*, are found the largest and most important industrial machinery importing houses. Many of the larger firms have branches in the city of Sao Paulo, while a few have branches in other cities of importance, principally Pernambucco, Bahia, and Porto Alegre. Sao Paulo is also the home of a number of large machinery importers and manufacturers. Few, if any, even of the large machinery houses, cover the entire country. There are in each of the port cities, such as Sao Luiz and Fortaleza, machinery importing concerns which cover their immediate territory, and which in many cases acts as agents for the houses located in Rio de Janeiro and Sao Paulo.

Most of the more important machinery houses are controlled and managed by Europeans, and have been established in Brazil for many years. They know the market thoroughly and each has to a great extent its own clientele. A client will frequently order a machine of a certain make from his machinery house, not knowing whether that firm handles the particular brand or not. Of the more important machinery houses in Rio de Janeiro, among the European firms, the Germans are in the majority and are strongly established. The English are likewise well represented. Among the American machinery houses nearly all are branches of American manufacturing concerns.

SCARCITY OF SKILLED MECHANICS

By WILLIAM C. BETZ

That there is a scarcity of skilled mechanics the writer is certain. On many occasions we have had to search for weeks and even months to fill vacancies in our machine and tool departments. We have had to resort to advertising in cities hundreds of miles away, where work was known to be slack, and even then we did not succeed in obtaining the men needed.

Men possessing skill and initiative are scarce and will be even more difficult to find in the future if manufacturers do not pay more attention to the training of apprentices. Another reason for the scarcity of skilled workmen is that it is becoming more difficult to induce the more intelligent class of boys to take up work in the metal trades, owing to the low wages paid, as compared with the wages in other trades.

As an example, let us consider the case of the factory electrician. It is not difficult to understand why a man of ability should not take an electrician's job in the shop at from 50 to 75 cents per hour, when he can obtain $1.10 per hour on outdoor work. The only men available for inside jobs are those who have not acquired the skill or training required for outside work or who desire to obtain an inside job during the cold weather. The latter type of workman generally obtains an outside job just as soon as the winter is over.

In the machine business, the need for skilled men is becoming greater, and the only way to keep up the supply is to interest more boys in the trade. This means that higher wages must be paid. Some years ago the writer was employed as an instructor of evening classes in the state trade school. At that time many people interested in the machine building industry predicted that within a few years the labor market would be so overrun with mechanics that wages would be unduly cut down. The present condition and the future prospects regarding the question of skilled mechanics prove conclusively that these predictions were not correct.

It might interest the readers of MACHINERY to know that at a meeting of the New Britain Industrial Council of Employment Managers some months ago it was voted to get out a statement showing the number of machine shop apprentices, compared with the number of journeymen in each plant. The plants that did not have a regular apprentice training system were asked to cooperate with the others in training men and boys in the crafts in order to insure a sufficient supply of skilled mechanics. This council represents some of the largest manufacturers in this section of the country. Under these conditions it is rather difficult to agree with the writer of the statements made in the article "Are Skilled Mechanics Scarce?" on page 532 of March MACHINERY.

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MACHINE TOOL TRADE WITH CHINA

The machine tool trade with China steadily increased during 1924, according to official Chinese customs statistics. Figures for 1925 are not yet available. The imports in 1924 were valued at approximately $150,000, as against about $72,000 in 1923, and $68,000 in 1922. In 1922 and 1923, Germany supplied more machine tools to China than any other country, but in 1924 the United States took the first place, with Japan second, Germany third, and Great Britain fourth. While the imports of machine tools and prime mover machinery increased in 1924, the importation of textile machinery dropped considerably. This was probably due to the fact that a number of large textile mills were being equipped in 1922 and 1923 and that there were not so many large projects in hand in 1924. The machinery imports during the first nine months of 1925 show a considerable decline, compared with the same period in 1924, but this was due to the disturbed political conditions and to the military operations that have taken place during the past year.

REPAIRING SURFACE GRINDERS

By JACOB H. SMIT

In checking a surface grinder to determine where corrections are necessary, it is well to start by tightening the grinding spindle. Then attach a bar to the spindle for holding an indicator, and with the indicator sweep the rear side of the table to determine whether its ways are at right angles to the spindle. If there is misalignment, take off the table, scrape the bearing surfaces and the vees, testing them from time to time with a straightedge or by using a scraped block and Prussian blue. Also try the table on the vees. The same procedure should be followed with the cross-slide; in fact, the cross-slide should be scraped first. Undue wear on the internal parts can also be attended to when the table and cross-slide are removed.

Care should be taken in cleaning the parts for reassembly upon the completion of the scraping. After washing the surfaces, rub oil over them and then rub this off. Often a certain amount of grit can be felt in the oil, which seems to come from the pores and small cavities in the scraped surfaces. If waste is used to wipe off the slides, the strands of thread remaining on the slides should be carefully picked off. After reassembling the machine, a light grinding cut should be taken off the table with the grinding wheel in the regular spindle. It is advisable to apply an indicator to the ground surface to be sure that the table is parallel with its bearing surfaces.

In the operation of some grinding machines that have been used for a considerable period of time, there will be a tendency for the vertical wheel-spindle slide to drop all of a sudden. If this occurs when a finishing cut is being taken, the work will be ground below size. The trouble is a result of looseness in the handwheel shaft of this slide and excessive side play of the slide, in combination with the vibration of the machine. These factors cause the handwheel to tend to adjust itself into a position with the heaviest part down. If the bevel gear fastened on the handwheel shaft has too much side play, the feed will be irregular, because if the handwheel shaft is pulled outward, the engagement with the other bevel gear will be spoiled and there will either be no feed or only a limited amount. Then, if the shaft is pushed in, the feed may be more than is wanted.

These troubles with the handwheel shaft can be eliminated by smoothing the thrust faces of the slide, handwheel, and collar, and using a brass washer between them to take up the play. A lock-screw may be used to tighten the feed-shaft lightly in taking finishing cuts, putting a piece of brass or copper in the screw hole to prevent marring the shaft.

If the spindle is worn, take a light grinding cut over its bearing surfaces. Then, if the bronze bearings have already been closed too far to permit tightening them on the spindle, put a sheet of paper or thin metal around the tapered male portion of the bearings to give them a new lease of life. Finally, scrape the inside of the bearings to a fit. If the pulley shafts are much worn at the bearings, an unnecessary amount of power will be consumed in driving the machine. Worn pulleys in combination with a crooked belt set up a large amount of vibration. It may be well to harden the shafts, grind them at the bearings, and provide bronze bushings in the pulleys.

The most important and most baffling job is to true up the magnetic chuck. Many toolmakers, when starting to handle a piece of work that must be machined accurately, grind off the magnetic chuck and then assume that it is straight, but this is not always so. Owing to the thinness of the chuck and the fact that it is made of cast iron and lead, a grinding wheel will load up or glaze quickly in taking such a cut and heat up the chuck so that it expands. Thus the chuck is likely to move up or down more or less while it is being ground. Care should be taken in selecting the grinding wheel, a soft wheel being the best to use. The wheel should be kept in good condition with a sharp diamond, and light cuts should be taken. As little heat as possible should be developed in grinding. Sometimes five or six light cuts of not more than 0.0005 inch each are necessary. Test the chuck with the indicator after each cut to determine the condition, and always start the next cut on the high side. It may be necessary to do a little scraping at times.

In one type of grinding machine on which the slides are fed by hand, grinding dust settles on the bearings of the slides and charges them so that the slides act as lapping plates and can be moved only with considerable effort. The remedy is to scrape off the bearing surfaces of the slides, scraping out heavy in the center and light on the ends. It will be surprising how easily the slides can be moved after this treatment.

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REDUCING WEAR ON TOOLS

By DONALD A. HAMPSON

In an article on page 392 of January MACHINERY, entitled "Drilling Tank or Boiler Plates," the statement is made that "any weaving of the plates will result in wearing off the corners of the drills." This is a factor in tool wear that is ordinarily overlooked or never realized. In order to increase efficiency in drilling, as well as other operations that require the maintaining of a sharp cutting edge, it is necessary to give this factor careful consideration. The dulling of the cutting edge of a tool means simply that abrasion has changed the shape of the edge produced by the grinder, so that it is rounded and will no longer cut into the work, but pushes its way through the metal.

Work that is not rigidly clamped in place springs from in front of the tool, and, on the rebound, strikes the cutting edge a blow that blunts or chips the edge more than would several seconds of steady cutting with the work clamped rigidly in place. In the case of drilling, there is the wear at the point and also the wear on the side of the drill, which gradually reduces the lands and thus makes drilling more difficult.

Drill wear resulting from insufficiently supported work is similar to the tool wear encountered in lathe and planer work. The planer tool used for finishing cuts must be given more attention than the roughing tool, and the difference in wearing qualities on different kinds of work is very noticeable. A tool may be used to finish a number of castings that are rigidly secured or that have proper supporting feet without the cutting end being unduly dulled. The same tool may be badly dulled, however, when machining a single casting of an equivalent area, which is so designed that it springs down as the tool passes over the unsupported portions. This is also true of other machining operations. Milling cutters will stand up between grinds only a fraction of their usual operating time when used on springy work, such as tubing.

The movement of springy stock simply beats down the edges of the cutting tool. This point is well illustrated by examples taken from the wire-forming machinery field. As all the material used in wire forming is fed from rolls, the cutting-off tool is required to make one cut for each piece formed. When the machines are used for flat or ribbon stock, various punching or piercing tools may be mounted upon the slides. Tools of the punch and die class, that is, those that cut instead of form the work, require the most frequent attention. The time required to sharpen and reset even the simplest of these tools greatly reduces the hourly production rate, and for this reason, the prevention of cutting tool wear has been given considerable attention by diemakers.

It has been found that some sort of a clamp or spring-actuated plunger, advancing ahead of the cutting tool, which holds the stock firmly against the die at the instant it is cut, will double the amount of work that can be done between grinds. The fact that the stock may pass between guides having a total clearance of only 1/32 or 1/64 inch does not eliminate the necessity for employing the clamp or spring-actuated plunger.

Has the Need for Apprenticeship Passed?*

By W. A. VIALL, Vice-president, Brown & Sharpe Mfg. Co., Providence, R. I.

APPRENTICESHIPS, in one form or another, have existed throughout the ages, coming down from the guilds of old to the more modern and elaborate plants of today. Manufacturers and educators have experimented from time to time to find the best means of educating and training workmen for a given industry. There is no branch of work in which the study of books is not a great help, but the knowledge of how to do things must largely be acquired by actually doing them.

At the present time, many seem to believe that mass production, requiring an operator trained to perform a single operation, has eliminated the need for men trained to do all kinds of machine shop work. Notwithstanding the effect of mass production, there is a constant complaint of a shortage of skilled labor, and when business in the metal-working field becomes active, this complaint is always heard. The fact is that there is today a need, not only for the skilled operator able to handle jobs on one type of machine, but also for the skilled workman who can turn his hand to any job that he may be called upon to do. Much has been done by technical schools to supply trained men, and courses have been developed, including both class-room teaching and shop practice, with the expectation of thus being able to meet very largely the growing need for trained men.

School Shop Cannot Take the Place of Actual Shop Training

From my observation and experience, I believe that school training, when successful, prepares a man to obtain the advantages of shop training in a much shorter time than is likely to be the case with an untrained mind. I firmly believe, however, that no matter how well the school shop training is carried out, it can in no way take the place of actual shop conditions.

The founders of our company felt the value of apprenticeship, brought up under it as they were, and its principles have been carried through in the training of their sons and grandsons. With such a background, it was natural that as much attention should be paid to the training of apprentices as was paid to other important matters. In other words, never did they consider that the training of young men was a minor question that could take care of itself.

In the earlier days the young men came into the works and received instruction in a more or less systematic manner. Placed under foremen, they were given tasks that were intended to give them an all-around training. Under such a method, the systematic moving from department to department was more or less a matter of convenience. Given an earnest, hard-working boy, the foreman liked to keep him on a job, because he helped him make a good showing in his department; whereas the less efficient lad was passed on from hand to hand before he had spoiled too much work and set up too heavy a record against the foreman of the department in which he was working. Under such a procedure, some boys received a more thorough training than others.

The Early Development of a Systematic Apprentice Training

Toward the end of the nineties, the late Richmond Viall, then superintendent, decided that the training given apprentices should be more systematic. Work was not only laid out for the apprentice as it had been in times past, but a supervisor was appointed whose duty it was to see that these plans were carried out.

The selection of a proper supervisor is a most important thing. He must not only be a thoroughly trained mechanic, but he must also be a man of character, capable of handling his job sympathetically, and last but not least, he must be able to keep up the boys' enthusiasm in their work. This is not an altogether easy task, but no part of a properly administered apprenticeship system is easy.

Requirements for Machinist Apprenticeship

In the early days, if a boy was physically fit and had a fair mentality, he was readily taken on as an apprentice. Later, when it was found that studies should accompany the training, it became necessary to raise the educational standard. For a boy to be eligible for a machinist apprenticeship now, we require that he must be not less than sixteen nor more than eighteen years of age. He must have had a good common school education equivalent to that necessary for graduation from the grammar schools of Providence, and possess a sufficient degree of physical development to fit him for the trade. Only boys of good habits, whose sight and hearing are unimpaired, are accepted. Boys addicted to the use of cigarettes are not favored as apprentices, nor are boys who are simply tired of school and are looking for a job in order to escape school work. It is important that boys should be mechanically inclined, and have a natural perception of mechanical matters, if they are to make a success in this line of work. A preliminary examination is ordinarily required to show how much knowledge the boy has of simple mathematics, including fractions, decimals, percentage, ratio, and proportion, square root, mensuration, etc.

Having convinced ourselves that the young man is worth trying out, we take him on probation for a period of three months. During this period we are able to observe his general fitness for the work. Is he at all mechanically inclined? Is he industrious? Is he going to be able to work with others? And finally, but not least, is he straight? Having passed the three-months period to our satisfaction, he is indentured. As we train apprentices in the machine shop, the drafting-room, the foundry, and in core-making and special work on automatic screw machines, the terms of indenture vary somewhat. We charge each applicant a fee, and in case the agreement, signed by the applicant and parent or guardian and ourselves, is broken, the money is not returned.

On the fulfilment of the apprenticeship, due allowance having been made for absences by reason of vacation, sickness, etc., a bonus is paid. We find among many employers the idea that indenture is not wise. We believe thoroughly that it is advisable and often necessary. Occasionally a young man will break away, despite anything that can be done, and forfeit the amount of his fee and his prospective bonus rather than continue on the job. But such cases are very rare. It is not a bad idea to inculcate in the minds of the young a regard for a contract obligation.

Course for Training Machinist Apprentices

We lay out a definite course to be followed during the entire term of apprenticeship. For the machinist apprentice it is as follows:

	Weeks
Lathe work	32
Drilling	6
Milling	20
Planing	12
Scraping	6
Thread cutting	3
Assembling and erecting screw machines or milling machines	24
Operating screw machines	5
Grinding	8
Assembling and erecting gear-cutters	24
Gear cutting	8

*Abstract of paper to be read before the meeting of the American Society of Mechanical Engineers in Providence, R. I., May 3 to 6.

Toolmaking 18
Repairs 18
Miscellaneous 12

It will be noted that not only does the apprentice have to do with the manufacture and assembling, but also with the operation of the various types of machines that we manufacture. In addition to the shop work, we established a course in class-room work. This requires two hours a week, on company time, during the first two years of apprenticeship, and four hours a week during the last two years.

The Class-room Work

The school conducted in connection with the machinists' apprenticeship course gives instruction in machine shop mathematics, including linear and angular measurement, screw threads and gearing, calculating feeds and speeds of machinery, indexing, etc., and in drafting, including jig and fixture work, cams, mechanisms, etc., all applied directly to the work of the shop. The instruction is in the form of lesson sheets on which the work is done by the apprentice. The course is directed to cultivating the reasoning powers and the power of observation, rather than being a matter merely of memorizing rules.

The drafting-room apprentices are an important factor in the mechanical world, and we have laid out courses in the shop that give them a practical idea of shop methods which they can use in connection with the drafting-room practice that they are taught.

One of the problems in connection with apprenticeship is to secure young men who are willing to undergo such a training. In this time of "white-collar jobs" and relatively "easy money" in operating machines, the task is more difficult than it was in the early days. The question of compensation is a most important one. We have adopted a scale suitable for our needs, but such a scale must be arranged by each employer.

By presenting the advantages of shop training to pupils of some of the high schools and technical schools, we have been able to enlist young men of more advanced education. Originally the plan of training contemplated making skilled workmen. But I think that the problem has grown to be a much broader one than this. We are able to show that there are possibilities open to well trained young men that are well worth their while.

Occupations of Graduates from Apprenticeship Courses

A recent investigation showed that in a list of about 350 graduates there were 8 proprietors, 6 superintendents, 12 officials of companies, 18 general managers, 22 general or department foremen, 67 foremen and sub-foremen, 25 salesmen, 32 draftsmen, 7 inspectors, 3 agents, 5 efficiency experts, 2 teachers, 3 advertising men, 10 engineer draftsmen, 13 mechanical engineers, 2 mechanics, 4 machine demonstrators, 38 toolmakers, 37 machinists, 8 patternmakers, and 21 molders and core-makers. It has been found that about 70 per cent of the graduates stay with the company for at least a year after the completion of their apprenticeship; and of those who leave to go with other firms, many return later. The management, including most of the heads of departments throughout our plant, are graduates from our training courses.

Is Apprenticeship Training Possible Only in a Large Plant?

What I have outlined in the foregoing paragraphs may make the average manufacturer feel that this is a splendid thing for a large company, but impracticable for smaller ones, and unfortunately this impression is difficult to remove. It is my belief that any company, whatever its size, can carry out this work if it will but put some one who is fitted to spend some of his time looking after the training of young men in charge of the work. It will repay itself many times over.

The National Metal Trades Association, through its committee on apprenticeship, has devised certain methods of procedure that have been put into force, and these have not only shown results from the graduates of their all-around training, but have also been wonderfully successful in training specialists. For example, in the case of automatic screw machines, it is well enough for an operator to be able to feed stock to the machine and gage his work, but it requires time and application to be an all-around operator who is able to plan his work, lay out his cams, make his own set-ups, and in fact, be independent of all instructors. Such training is now given with success.

Factors Necessary for Successful Apprentice Systems

We have started out, as I have already said in the foregoing, with a management that is thoroughly in sympathy with the work; we have impressed its necessity upon all of our organizations; and we stand back of it in every way. We endeavor to obtain the best type of young man that we can get hold of. We endeavor to take care of him, if he is from out of town, by furnishing a house where he can obtain good quarters, and we endeavor to give him a thorough training in the craft to which he is apprenticed.

If manufacturers could fully appreciate not only the joy of achievement in their production and of their success measured by the money that they make, but also the joy of taking and molding men who are to be leaders in the years to come, they would receive greater consideration at the hands of the people at large. We often are inclined to think that the way to improve the social conditions of today is through schools, recreational agencies, welfare organizations, etc., but there is no better nor more satisfactory way than for manufacturers to get behind their jobs and take young men and bring them up to be worthy followers of the many brilliant minds of the past.

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OXY-ACETYLENE EQUIPMENT IN RUSSIA

According to a statement made by A. A. Heller, treasurer and general manager of the International Oxygen Co., Newark, N. J., who recently returned from a business trip to Russia, there is a great field for oxy-acetylene cutting and welding equipment in that country. A good deal of work there could be carried on by the oxy-acetylene process, especially in railroad work, shipbuilding, automobile and airship plants, and in the manufacture of steel barrels and numerous other metal articles. Great quantities of worn-out railway and industrial machinery will have to be junked by the cutting torch.

The application of welding and cutting by the oxy-acetylene flame has never been highly developed in Russia, and there are great possibilities for its extensive use. The International Oxygen Co. has obtained a contract to erect six oxygen plants, two acetylene plants, and one welding plant in the Soviet Union within the next three years, and will also establish two welding schools. An arrangement has been made whereby a separate company has been formed in which the Soviet Metal Syndicate has a half interest. This form of organization places the business on a par with state organizations and assures the widest possible market for the product. The operating company is to be known as the Russian-American Compressed Gas Co. Arrangements are under way for equipping 80 railroad shops with electric and oxy-acetylene welding apparatus and for scrapping 8000 locomotives by oxy-acetylene cutting, as well as several old battleships and other metal aggregating thousands of tons.

* * *

PHILADELPHIA SESQUI-CENTENNIAL EXPOSITION

Definite announcement has now been made that the International Sesqui-centennial Exposition to be held in Philadelphia this summer will open June 1. The Palace of Machinery, Mines, Metallurgy, and Transportation was the latest structure to be contracted for in the exposition building scheme, but it is expected that it will be ready on time. It will occupy over 325,000 square feet of space, and will be erected at a cost of $740,000. It will be of steel frame construction with stucco finish.

OXY-ACETYLENE WELDING OF COPPER

By S. W. MILLER
Union Carbide and Carbon Research Laboratories, Inc.

As copper has a strong affinity for oxygen when molten, it becomes saturated with oxygen during the melting, and if cast in this saturated condition, the pigs will be brittle, the center of their top faces will be lower than their edges, and they will have a bad appearance and fracture.

This is overcome by stirring the melted bath with poles made of green wood, the process being called "poling." If poled too long, the pigs will rise in the center, and will be porous. When the poling is carried to just the right point, the pigs will have a flat surface, neither concave nor convex, and will still be free from porosity. Such copper is called "tough pitch." This material—the usual commercial product—still contains a considerable amount of cuprous oxide, Cu_2O, and, due to the presence of this oxide, has a peculiar property when hot, in that for some distance below its melting point it is brittle and cannot be hammered or rolled, the maximum working temperature being a dull red. This brittleness is at a maximum just below the melting point, at which temperature the copper has practically no strength, so that just after the welding operation is completed, if there is any stress at all in or near the weld, cracks appear in either the weld or base metal, and as they cannot be welded, the operation is a failure.

The same general statements are true when either ordinary brazing or bronze-welding of copper is resorted to, though the damage is not so great in these cases. It is very easy to overheat copper in either way, and reduce the resistance of the joint to a point that is dangerous where high strength is needed. Much effort has been wasted in trying to correct this trouble by the use of special welding rods containing various deoxidizers. But it has seldom been recognized that even if the weld metal is clean and strong, the damage is still present next to the weld in the base metal.

AVERAGE STRENGTH OF A NUMBER OF WELDS IN DIFFERENT TYPES OF PLATE

	Ultimate Strength, Pounds per Square Inch	Elongation in 2 Inches, Per Cent
Commercial plate weld.....	15,520	8.1
Deoxidized plate weld*.....	26,280	23.0
Original plate	32,000	....

*None of the welds were hammered or heat-treated. Such treatments would improve the physical properties.

About four years ago, the author made a series of tests of copper welding rods containing such deoxidizers as silicon, manganese, aluminum, phosphorus, and various combinations of them. Some of them seemed to work well under the blowpipe and to give sound welds; but, rather strangely, when the rupture of a test piece, either by bending or in tension, occurred outside the weld, it was just next to the vee, parallel to its side, and in the case of tensile tests, at practically the same load per square inch of base metal, regardless of the composition of the welding rod. This showed that the base metal must be defective at the point of rupture, and that the rods had nothing to do with the difficulty.

Of course, it has been common knowledge for years that commercial copper is injured when heated by a reducing flame, but it does not seem to have been realized up to the time of these tests that the trouble with copper welding was due to this cause, the reducing flame of the welding blowpipe being responsible.

The action is really twofold, as was brought out clearly by a microscopic examination:

1. The thin melted zone just next to the vee recrystallizes when cooling, and any oxide present collects at the grain boundaries, weakening them and therefore the metal.

2. Such of this oxide as is exposed to the action of the envelope flame is reduced to copper, which occupying less space than the oxide, leaves spaces along the grain boundaries, weakening the metal still more. This reducing action is very rapid, as can be seen by playing the envelope flame across a surface of scaled copper. As soon as the scale is red hot, the surface becomes the usual copper red color, only a few seconds being needed for the change to occur.

Sections of welds bent slightly and examined under the microscope showed that the path of rupture always followed the visible defects at the grain boundaries. As the primary cause of the trouble was evidently the cuprous oxide in the metal, some deoxidized copper was made by casting ingots 2 inches square and forging them to the desired size.

Silicon was found to be by far the best deoxidizer, and only a small residual amount of it was found necessary, say from 0.05 to 0.10 per cent. There was no difficulty at all in forging it at a sweating heat—that is, when it was almost melted—and at no temperature below this was there any cracking.

Welds were made in this material with the different rods, and much improvement was found. But the best results were not obtained until a welding rod of a composition similar to the base metal was used. As properly deoxidized copper can be forged easily at any temperature, there can be no danger of welding strains cracking it, and as it is just as malleable as commercial material, there is no trouble in cold-working it. There is also no difficulty in obtaining it, as any manufacturer will make it if asked to do so.

It is probably true that the complete realization of the possibilities of copper welding will cause an increased demand for welded copper products, which will be of great advantage to industry in many lines. It should be understood that the presence of oxide can be determined positively by the microscope, or practically by heating a piece of the metal to a bright red and bending or forging it. If it cracks, oxide is indicated, and even if by chance something else causes the cracking, it is not fit for welding and should not be used. The tests referred to were made at the instance of the Union Carbide and Carbon Research Laboratories.

* * *

FOUNDRY INSTRUCTORS TO MEET IN DETROIT

The meeting of foundry instructors that was held in conjunction with the 1925 Syracuse meeting of the American Foundrymen's Association was so successful that it has been decided to make this meeting an annual occasion. The second meeting will be held in Detroit at the time of the second international foundrymen's congress and the thirtieth annual convention of the foundrymen's association to be held there September 27 to October 2. Foundry instructors in the various technical colleges and schools throughout the country have been invited to participate. Brief papers will be read describing the foundry courses at Purdue University, Carnegie Institute of Technology, and the Universities of Michigan and Illinois. Following the reading of the papers, there will be a general discussion of foundry instruction. In addition, an inspection trip is planned to the University of Michigan at Ann Arbor, a short distance from Detroit. All foundry instructors attending the meeting will be invited to participate in the technical sessions of the foundrymen's convention and to inspect the exhibits of foundry equipment and supplies held in conjunction with the exhibit.

At the convention there will also be a special session for malleable foundry men in the form of a round table discussion of practical shop problems. This discussion is planned for the benefit of the practical shop man as well as the metallurgist and executive. Some of the subjects to be discussed will cover sand for core making, pattern standardization, shrinkage in malleable castings, and machining qualities of malleable castings. F. L. Wolf, technical director of the Ohio Brass Co., will preside at the round table meeting.

* * *

An international exhibition is to be held in Tiflis in the Soviet Republic of Georgia during May and June, according to the Russian Information Bureau at Washington.

Measuring by Optical Means

Applications of Two Optical Instruments Intended for Use in the Shop, Tool-room, and Inspection Department

OPTICAL instruments are peculiarly suited to the measurement and inspection of parts, because they permit such a great enlargement of the surfaces being observed that very small inaccuracies in lengths or contours can readily be detected. Applications of two measuring instruments based upon optical principles, which have recently been developed by the Bausch & Lomb Optical Co., Rochester, N. Y., are described in the following. These instruments are intended for use in the shop, tool-room, and inspection department and can also be considered as laboratory equipment.

Using an Optical Thickness Measure

Parts may be measured accurately to within 0.0001 inch by means of the direct-reading thickness measure illustrated in Fig. 1. This instrument consists essentially of an upright *A* to which is gibbed a slide *B* that may be adjusted vertically on the upright by turning handwheel *C*. Mounted on the slide is a housing *D* in which is contained a scale that moves vertically with plunger *E*. A second horizontal scale in housing *D* slides on an incline over the vertical scale when sleeve *F* is revolved. The relation of the two scales to each other for any setting of the plunger may be readily observed by means of eye-piece *G*, through which they appear as shown in Fig. 3. Light for assisting the observation of the scales is furnished through rectangular prisms in part *H*. The plunger rests on the work solely by gravity.

The scales within housing *D* have a range of 1 inch, and upright *A* is of sufficient height to permit the measurement of an additional 5 inches, so that the capacity of the instrument is 6 inches. If the measurement to be made is less than 1 inch, the upper edge of slide *B* is set to a zero graduation on the upright, but if the measurement is more than 1 inch, as in the example illustrated in Fig. 1, the upper edge of the slide is set to the proper inch graduation on the column. In other words, the slide is always set on the column according to the number of whole inches in the measurement to be made, and the fractional dimension is determined by means of the scales in housing *D*.

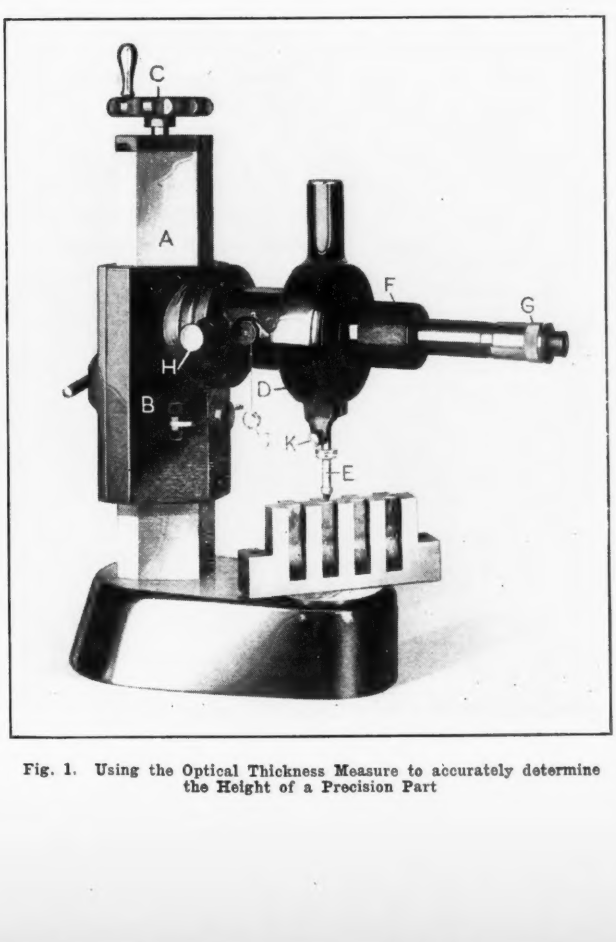


Fig. 1. Using the Optical Thickness Measure to accurately determine the Height of a Precision Part

Precision gage-blocks or quartz blocks of accurate thickness are used between the plunger and the base anvil in setting the slide to the proper vertical position for measuring parts, and while this is being done, the scales are observed through the eye-piece until a reading such as shown at the left in Fig. 3 is seen, when the plunger comes in contact with the gage or quartz blocks. After the slide has been positioned, it is clamped to the column by means of the handle at the back. With this method, an accurate setting of the instrument can always be made, regardless of wear of the plunger or anvil.

In measuring a part, ball *J*, Fig. 1, is pulled to raise the plunger sufficiently to permit placing the work on the anvil. Then the plunger is allowed to descend on the work, and as it does, the vertical scale *X*, Fig. 3, moves with the plunger. Next, while looking through eye-piece *G*, Fig. 1, sleeve *F*, is revolved until the two horizontal lines on scale *Y* are placed evenly over one of the index lines on scale *X*. Each graduation on the vertical scale *X* represents 0.01 inch, and each graduation on the horizontal scale, 0.00002 inch.

In the example illustrated at the right in Fig. 3, slide *B*, Fig. 1, was set to the 2-inch graduation on the upright, and so the part being inspected measures 2.75655 inches, as shown in Fig. 3 The maximum vertical movement of the horizontal scale is equal to only one space on the vertical scale, and so at no time can the two horizontal lines on scale *Y* be placed over the wrong graduation on scale *X*. Since the horizontal scale moves vertically as well as horizontally, it obviously does not always appear in the exact center of the eye-piece.

One of the features of the instrument is that the scales are on glass pieces located only about 0.0002 inch apart in housing *D*, Fig. 1. The housing is hermetically sealed, so that the graduated pieces are unaffected by changes in the temperature of the room or the person using the instrument. When sleeve *F* is revolved, the horizontal scale is shifted to and fro through an eccentric mechanism on a

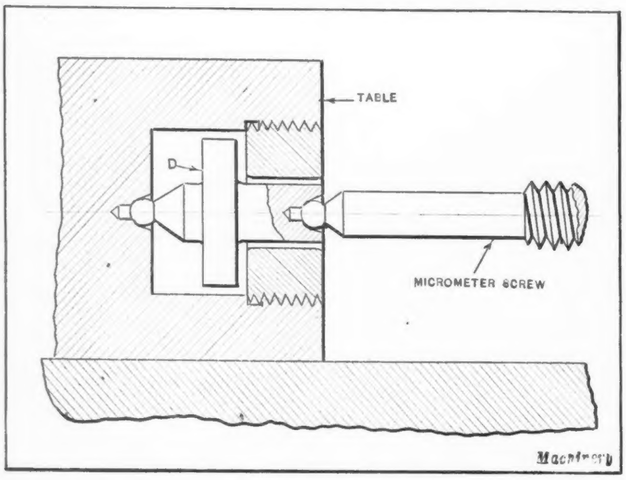


Fig. 2. Construction of the Micrometer Screw and Thrust Pin in the Toolmaker's Microscope shown in Fig. 4

hardened gib. The plunger is guided in a bearing at each end.

When the instrument is to be used as a comparator for inspecting large quantities of a given part per day, screw *K* is set to limit the movements of the plunger to a small amount that will permit a rapid substitution of the work pieces. There is a safety device that prevents the operator from turning the slide adjusting screw when the work placed on the anvil is lower than that for which the instrument is set. Also, a retarding mechanism prevents the plunger from dropping too suddenly. This mechanism consists of a rack on the plunger which engages one gear in a series, of which the last gear drives a small paddle fan.

Applications of a Toolmaker's Microscope

Both linear and angular measurements can be made by means of the toolmaker's microscope illustrated in Fig. 4, and hence this instrument is especially applicable in connection with screw threads, gages, small jigs, and other precision parts. It is intended primarily for shop use, and not simply as an inspection device. The instrument consists essentially of a base on which is mounted a work-table that may be moved horizontally and transversely beneath the vertical microscope *A* by means of micrometer screws *B* and *C*, respectively, which actuate separate slides. The microscope is adjustable on a post that is fastened to the rear of the base.

Screws *B* and *C* have a range of 1 inch, and are each equipped with a graduated collar that facilitates reading to 0.0001 inch without using a vernier. As illustrated in Fig. 2, each micrometer screw has a ball at the opposite end that engages the countersunk end of a thrust pin *D* within the slide. This thrust pin likewise has a ball end which, in turn, engages a countersunk hole in the slide itself. This construction is said to obviate any error that might result if the micrometer screw came in contact with the slide directly and was out of parallel with it. Each slide is held in contact with its corresponding micrometer-screw thrust pin by means of springs.

In the center of the upper slide or table there is a circular opening covered by glass. Light entering reflector *E*, Fig. 5, is reflected by mirrors upward to a condenser lens in the center of the base of the microscope. The eye-piece of the microscope magnifies forty times, with the result that very small errors in the work can easily be detected. With the aid of an extra objective, even greater magnification can be attained. Cross-lines are etched on two different glass disks of the protractor eye-piece, and one of these disks can be swiveled relative to the other so as to permit changing the angular relation of the cross-lines. The stationary cross-line is provided with graduations that facilitate setting the movable line at any desired angle between 40 and 70 degrees. In measuring a part or inspecting an outline, different points on the work are lined up with these cross-lines, and since the lines are dotted, it is an easy matter to make an edge or other point of the work coincide with the lines. By means of an ingenious prism device in the microscope, the table, seen through the eye-piece, always moves in the direction in which it is actually being adjusted.

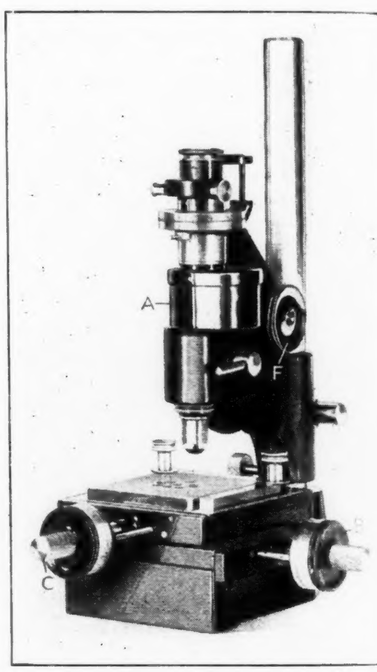


Fig. 4. Determining Center-to-Center Distance and Diameter of Holes

After the microscope has been positioned approximately on the upright for a given job, the eye lens is focussed on the cross-line in the eye-piece; then the microscope is focussed on the object by revolving thumbwheel *F*, Fig. 4. This wheel actuates an accurate rack-and-pinion mechanism which causes the microscope proper to move vertically on a slide. Protection of this slide and mechanism from all dust is insured by a cover of soft leather. Various attachments can be fastened to the bottom end of the microscope as required: for instance, a vertical illuminator may be applied for lighting up objects that exclude the light coming through the glass in the center of the table.

Measurements of parts placed on the table can easily be made by lining up one edge of the surface or hole to be measured with the cross-lines in the eye-piece, observing the readings of the micrometer-screw collars, shifting the table to bring the other edge of the hole or surface coincident with the cross-lines, again observing the micrometer-screw collar readings and finally subtracting one reading from the other to obtain the desired dimension. Measurements can be made sidewise and crosswise in this manner.

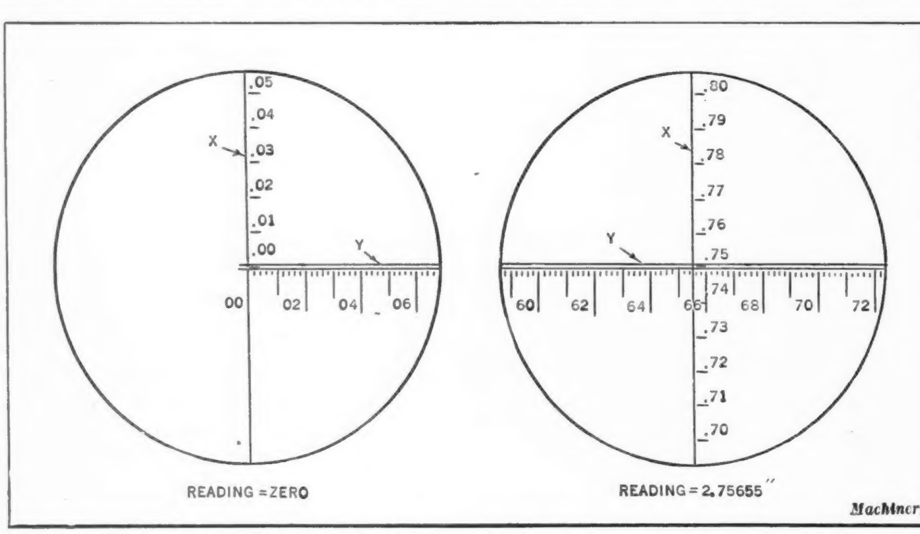


Fig. 3. Readings taken through the Eye-piece of the Optical Thickness Measure

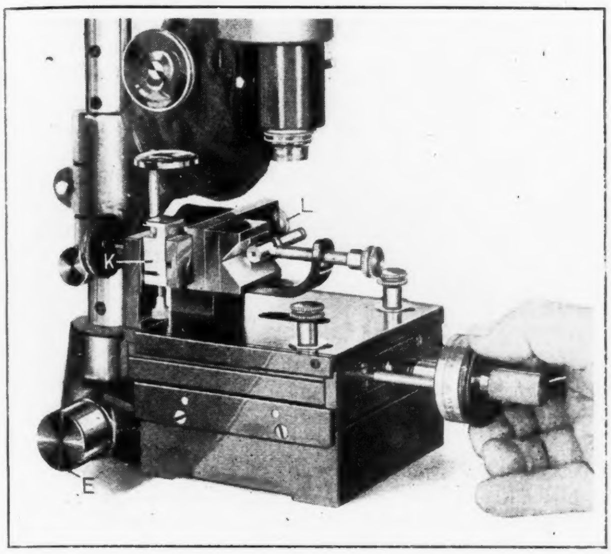


Fig. 5. Device employed to tilt a Screw when inspecting it in the Toolmaker's Microscope

An unusual device is incorporated in the toolmaker's microscope to permit screws to be tilted according to the helix angle, in inspecting the threads. This tilting is necessary in order that the true plane of the thread on both sides of the screw can be brought directly perpendicular to the microscope. It will be obvious that the screw must be tilted in opposite directions to observe the same thread on opposite sides. To observe the thread on the second side of a screw, it is also necessary to shift the screw lengthwise one-half of the lead; otherwise the top of the thread would be observed on one side and the root on the other side. In tilting a screw both ways it is important that the tilting be accomplished on the same axis, and it is convenient to make this axis the center of the screw. This axis of tilt can easily be obtained by clamping one end of the screw in a V-block, as illustrated in Fig. 5.

Taking Measurements of Screw Threads

The first step in measuring a thread is to determine the helix angle of the top of the thread and of the root, along the top of the screw, and then select the mean between the two angles as the angle at which to tilt the screw when measuring the thread on the opposite side. The movable dotted cross-line in the eye-piece is first lined up with the top of the thread by swiveling the eye-piece, and then the helix angle of the thread is determined by looking through the small magnifying glass *G*, Fig. 6, to observe the reading of graduations on collar *H* relative to an index line on collar *J*. The screw is then shifted lengthwise to bring the root of the thread in focus, and the eye-piece is swiveled to make the same cross-line coincide with the thread root. The position of the graduations on collar *H* is then again observed, and the mean helix angle found by adding the previous reading to this one and dividing the sum by 2. Collar *H* is graduated to 20 minutes, and provided with a vernier reading to 1 minute.

When the mean helix angle has been established, the screw-holder is tilted that amount by means of the mechanism at the left-hand side of the table, as shown at *K*, Fig. 5, on which there is a graduated scale that facilitates the setting. The direction of tilt depends upon whether the front or the rear side of the screw is to be observed first. After the screw has been tilted, the whole microscope stage with the screw to be measured is shifted by means of the front and side micrometer screws until the "60-degree focussing point" appears concentric in the field of the microscope. Revolving thumb-wheel *F*, Fig. 4, will focus the microscope to the "focussing point," thereby establishing the theoretical plane in which the screw thread is to be measured.

Next, the whole microscope stage with the attachment is shifted beneath the microscope to bring the profile of the thread into coincidence with the cross-lines of the eye-piece. This is done by turning the front micrometer screw and screw *L*, Fig. 5, for the side adjustment only. When both cross-lines coincide with the two sides of the thread profile, the included angle of the thread may be read directly. A reading of the graduations on collar *H*, Fig. 6, is then again taken to determine the angle of the thread vee with the axis of the screw.

With the vee of a thread on the front side of the screw coinciding with the corresponding vee of the cross-lines in the eye-piece, the reading of the front micrometer collar is observed. If the top of the thread is to be examined, the vee of the cross-line should intersect at the top point of the thread, but if the root is being inspected, the cross-line should intersect at the vee of the root. Of course, the cross-lines of the eye-piece will not intersect exactly at the top or root of a thread, since the threads are flattened slightly at these points. After reading the micrometer setting, the front micrometer screw should be revolved to bring the thread on the opposite side of the work beneath the microscope; the work tilted the amount of the mean helix angle in the opposite direction to that in which it had previously been placed; and the work advanced one-half of its lead by revolving screw *L*, Fig. 5, to again bring the top, or the root of the thread, as the case may be, in focus beneath the microscope. If the micrometer screw at the right-hand end of the table were turned instead of screw *L*, to shift the work one-half the lead, there would be an error, since the work would not be moved in the plane in which it is tilted.

The reading of the front micrometer-screw collar is now again observed, and from this reading the previous reading is subtracted, to find the outside diameter or the root diameter of the work, depending, of course, on whether the tops or roots of a thread are being inspected. Pitch diameters can be readily calculated when the theoretical outside and root diameters are known.

In measuring the lead of a thread, the screw may be held in male or female centers or in blocks. After one cross-line of the eye-piece has been lined up with one flank of a thread, the reading of the right-hand micrometer screw is taken, and then this micrometer screw is revolved until the same cross-line coincides with the same flank of the next thread. Then by observing the reading of the right-hand micrometer screw, and simply adding or subtracting this reading from the previous one, as may be required, the lead is determined. When a set of readings has been made along a screw, it is a good plan to turn the screw one-quarter of a revolution and then repeat the readings to determine whether or not the lead is uniform. Sometimes it is desirable to take such readings at three or four positions around the screw.

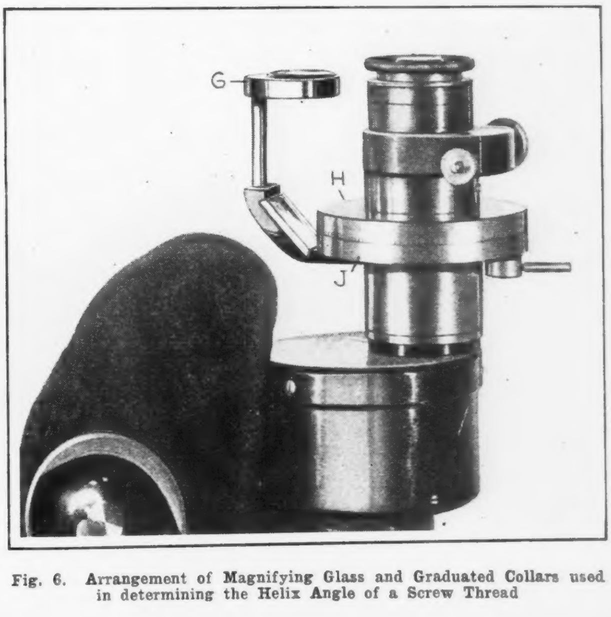


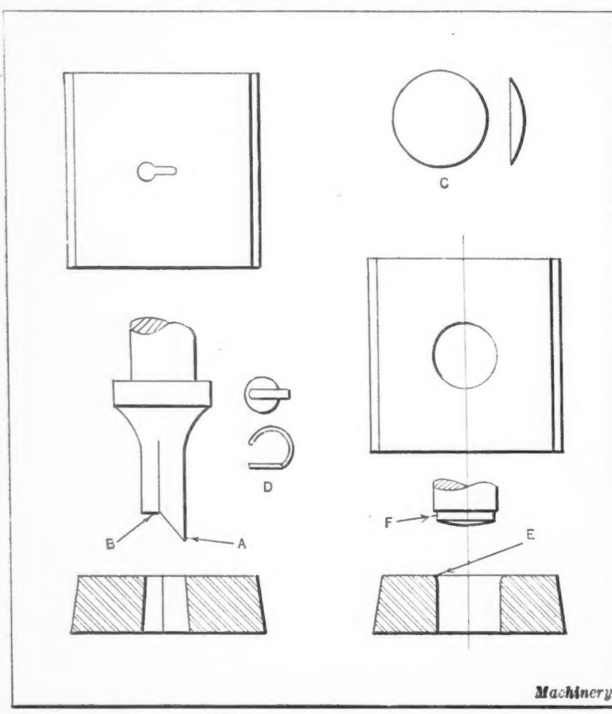
Fig. 6. Arrangement of Magnifying Glass and Graduated Collars used in determining the Helix Angle of a Screw Thread

FORMING AND BLANKING AT ONE STROKE

By EARL R. PHINNEY

Diemakers and designers often overlook the possibilities of forming and blanking small parts at one stroke of the press ram by shaping the end of the blanking punch. When this can be done, the necessity for making a separate forming tool is eliminated. For instance, the blank *C* in the accompanying illustration can be formed to the convex shape shown, by simply rounding the end of the punch to a radius slightly in excess of that desired on the blank. The punch in the lower left-hand corner is used to produce the part shown at *D*. This piece is termed a "pin catch," and millions of them have been made by tools similar to the one shown.

The die is made the same as any ordinary blanking die, of a size and shape that will produce the developed blank. After the punch has been sheared into the die, the end is milled to the shape shown, which must be determined by experiment. After the shape has been established, a gage or templet is made from a piece of sheet steel which can be used as a guide when sharpening the punch. When the tool is in operation, the point *A* enters the stock first, and as it descends, the



Dies designed for blanking and forming at One Stroke

stock is curled away from the inclined edge. When the flat portion *B* reaches the stock, the upper rounded portion of the catch has been completely formed, so that the piece *D* is completed when the flat portion is blanked out by end *B*.

Another type of die, used largely in the jewelry industry, is shown in the lower right-hand corner of the illustration. This design is referred to as a "pinch-off" tool or die, and as the name implies, it pinches off the stock after drawing the blank. This tool is used in the production of shallow cup-shaped blanks which are made from thin, soft metal such as brass, silver, or rolled-gold plate. As an example of the use of this type of die, assume that a cup 1/2 inch in diameter, with a wall 1/16 inch high, having its base slightly rounded is to be made from stock 0.010 inch thick. A hole slightly less than 1/2 inch in diameter is first bored in the die, and the upper edge of the hole is rounded to a radius of about 1/64 inch, as shown at *E*. The die is then hardened and lapped to a mirror finish, care being taken to keep the hole straight, after which the radius *E* is stoned to remove all tool marks.

The punch is next turned and filed to a snug fit in the die, and a radius is formed on its end to produce the required radius in the bottom of the blank. The end of the punch is then turned down as shown at *F*. The length of the step thus formed is made equal to the height of the cup measured on the inside, while the diameter is less than the large diameter of the punch by an amount slightly less than twice the thickness of the stock. The step portion should be smooth and tapered slightly toward the end so that the blanks can be easily stripped from the punch. In making a cup of the size specified, the diameter of the step end would be about 0.478 inch. This causes the punch to have an ironing effect on the stock which prevents it from wrinkling. The shoulder formed at the end of the step should be square and sharp, because it is this part of the punch that pinches off the stock as it enters the top of the die.

The punch is so located in the press ram that the blank is pushed completely through the die. When the punch is withdrawn, the walls of the blank spring out slightly and catch on the sharp edge of the die, causing the blank to be stripped from the punch. The lower face of the die is ground off occasionally to keep the edge of the opening sharp. In making a die of this type, care must be taken to keep the hole from being bell-mouthed, as otherwise the blank would stick to the punch. Of course, if a suitable grinder is available, dies of this type can be more easily and accurately produced by grinding after the parts have been hardened.

Blanks of irregular outline are also produced by tools of the type described. The punch is first made to correspond to the shape of the outside of the blank required, but without a step on the end. The punch is then hardened and faced off flat, after which it is used to broach the opening in the die. After the die has been broached, the punch is annealed and a step formed on its end by milling wherever possible and chipping or filing the points that cannot be milled. The radius at the edge of the die opening is first filed, and then stoned smooth after the die is hardened.

* * *

JOHN ERICSSON MEDAL

The American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., has established a medal to be known as the "John Ericsson Medal" in memory of the great engineer and scientist in whose honor the United States Government will unveil a memorial at Washington on May 29. The medal will be awarded by the society not oftener than once every second year to American citizens of Swedish birth or descent, or to Swedish citizens, as a recognition of distinguished accomplishments in science and engineering. The award will be made on recommendation of a committee comprising four members of the Academy of Engineering Science of Sweden and four members of the American Society of Swedish Engineers, a society founded in 1888 and having a membership of about 500. The medal is of solid gold, having on its face, in relief, a portrait of John Ericsson, and on the reverse side, the emblem of the American Society of Swedish Engineers. It is inscribed with the name of the man to whom it is awarded and the year, together with the words "For Distinguished Achievements in Science and Engineering." The first award will be made at the unveiling of the John Ericsson monument.

* * *

DEPENDABILITY OF THE AIR MAIL

Just as the Twentieth Century and the Broadway Limited trains between New York and Chicago have their special patronage, while the bulk of the travel goes by the slower trains, so the air mail serves a special purpose for rapid mail transportation, while the bulk of the mails will continue to be forwarded by train. It is of interest to note that the air mail has proved unusually dependable during the trying experiences of the past winter. Snows, fogs, blinding rains, and sleet have proved unable to interrupt the air mail schedules. During one of the heavy blizzards, when the important trains between Chicago and New York were all running late, the air mail out of Chicago arrived in New York two hours ahead of time, and the mail was delivered at the post office in New York considerably ahead of the regular fair weather schedule.

The British Metal-working Industries

From Machinery's Special Correspondent

London, April 16

DURING most of the past month, business in the metal-working industries was distinctly good and showed a continuance of the steady increase that has been evident for some time. Although orders fell off slightly toward the end of the month, it was probably due to transitory causes, such as the Easter vacation and the approaching end of the nation's financial year, and in spite of these perennial yet momentary adverses, everyone is optimistic about future business. Those manufacturing firms that have paid especial attention to improved design, production methods, and sales organization are reaping the most benefit, and the determination to equip themselves to meet foreign competition is having beneficial effects. As a general sign that prosperity is gradually but surely returning, the cost of living during the first three months of this year has fallen steadily from 77 per cent to 72 per cent above the 1914 cost, and unemployment decreased by 210,000.

General Machine Tool Business

Machine tool makers have lost most of their anxiety about the future, and seem to be settling down to a steady and slowly increasing business. No one anticipates or even wants a boom, but all are hopeful of a still greater stimulation when the present crushing taxation of the country is lightened. There can be no question that European debt questions are holding up industrial enterprise in this country, and until settlements are made and the relation between employer and employe becomes more cordial, there is not likely to be any startling improvement in engineering conditions. Second-hand machines have now been largely absorbed, and the sale of new British machine tools has improved in consequence.

Of the types of machine tools, probably grinding machines, especially segmental wheel and surface grinders, are receiving the largest share of attention. Orders are good, and widespread in origin. Inquiries and orders are also good for turret lathes, and milling and drilling machines, while there is an increasing interest in sheet-metal working tools, presses, and forging machines. Planer and woodworking machinery makers all report unusually slack times. Small tool makers seem busy, but stocks are still being bought rather sparingly. Competition is particularly keen, and price-cutting of twist drills persists. Business seems to be divided fairly evenly among a large number of makers.

Although the textile industry is rather slack and the cotton trade depressed, Manchester district engineers are quite well occupied; indeed, from all quarters—London, Midlands, Yorkshire, and Scotland—come reports of satisfactory business.

Railway Engineering Field Active

Orders for railway equipment are excellent. Home orders have been placed all over the country for at least a hundred express, freight, tank, and electric locomotives, a hundred steel coaches, five thousand cars for coal, minerals and merchandise, 6000 tons of chairs and 2000 tons of fishplates. In addition to these orders, there are many promising inquiries for locomotives and cars for various countries abroad. Machine tool makers are benefiting indirectly to some extent, but few orders are coming direct from the railways. Foreign railway orders are fairly good.

Shipbuilding Increasing

February showed a good increase in shipbuilding orders, and March has bid fair to sustain it. There is no doubt that the shipbuilding and engineering industries in Scotland are improving. A number of motorships are being built, and it is probable that the tonnage of motorships under construction is now 50 per cent of the total.

General Engineering Field

Constructional engineers are fairly well employed, but no very large contracts have been received or are anticipated. Transmission engineers and gear-cutting firms are generally busy. Boiler makers are very quiet indeed, but gas and oil engine manufacturers are experiencing a moderate demand in home and foreign markets. Most hydraulic and pumping engineers are busy. Electrical engineers are all well occupied on a steady trade.

The automobile industry is still flourishing, particularly the manufacture of light cars and heavy goods and passenger vehicles. Many firms have had good financial years and are still working at full pressure, although a temporary check was caused by the prospect of an engineering lock-out. Motorcycle and bicycle manufacturers are doing a good business in overseas markets.

Makers of pulverized fuel equipment are very busy, orders having been received from all parts of the world, three contracts to one firm from London, Wales, and Buenos Aires, alone totalling £1,200,000.

Conditions Quiet in Iron and Steel Trade

Business in the iron and steel trades is still quiet. Buyers are few and cautious; labor unrest, and the state of continental rates of exchange are among the principal contributory factors. The Association of Steelworkers of England and Scotland have agreed, after a year of free prices, to re-establish control of prices for certain classes of steel, and it is believed that this effort to keep prices at a profitable level will be more successful than in the past.

Overseas Trade

Following a jump in December and a drop in January, the value of machine tools exported in February has again risen to £170,190. A comparison of the figures for the last three months is most interesting.

	December	January	February
Exports, tons	1435	916	1595
Imports, tons	435	467	594
Exports, value	£147,769	£123,865	£170,190
Imports, value	£72,254	£67,261	£57,246
Exports, ton-value	£103	£135	£107
Imports, ton-value	£166	£144	£96

Exports rose to a high figure in tonnage and maintained a high figure in ton-value, though less than the unusually high ton-value of January. Imports also were high in tonnage, but fell heavily in ton-value. For the month, imports were actually of lower ton-value than the exports. These records point unmistakably to a flood of cheap imports. Tools and cutters were exported to a slightly higher value, the figures for December, January, and February being, respectively, £48,045, £45,064 and £49,594.

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The airplanes used in connection with Captain Wilkins' polar exploration are built entirely of metal, with oxy-acetylene welded joints. A complete welding equipment will be installed at Point Barrow, the most northerly point of land in Alaska, which is the base of the expedition. This is the first time that oxy-acetylene apparatus has been brought along as part of the regular equipment on a polar exploration expedition.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE 'BUSINESS CYCLE'

So much has been said and written during recent years about "business cycles" that many business men have been influenced to feel that every period of prosperity is sure to be followed by one of depression. These and others look on the recent fall in prices on the Stock Exchange as a certain indication of a coming depression in business, and this feeling has made some business men pause and wait for the effect, which has caused a slowing down of business in certain lines; in others, the seasonal slowing down would have come about this time in any event.

The aftermath of the wild speculation which followed Coolidge's election has resulted in no marked ill effects on general business, which indicates the strength of our financial structure. The three basic industries which determine business activity in general are the iron and steel industry, the automobile industry and the building industry. When these three are active, it follows that the railroads have a liberal amount of freight traffic, which is their principal source of revenue. The statements of the Department of Commerce and other authorities indicate that present conditions compare favorably with those of a year ago and that the outlook points to a considerable period of activity for all four of these great industries.

Certain it is that no system ever will be devised to regulate the unchangeable economic laws; but the reserve banking system has made a recurrence of our former financial panics unlikely, and has provided machinery for establishing more uniformity in business activity than we ever have had.

Some years ago a well-known banker, speaking before a manufacturers' association, stated that in his opinion the business cycle, except as it was influenced by unusual crop conditions or excessive speculation, was mainly a product of the human mind; the cycle consisting of four periods—hope, confidence, doubt and fear. The significance of this statement gradually is becoming more and more recognized. The most important factor in maintaining good business is to provide steady purchasing power and not to overstock or overextend, which is exactly the policy that our business men have been following for months. Manufacturers' associations should concentrate their efforts upon the problem of maintaining steady employment and sustained purchasing power, because nothing will keep the peaks and valleys of the business curve at a more even level than a uniform purchasing power by labor regularly employed the year around.

* * *

STUDYING ERRORS IN DESIGN

Although many excellent treatises dealing with the basic principles of machine design have been published, and designers find such books indispensable because they contain useful data, established facts and standard formulas, the young draftsman or designer soon learns that developing or originating various forms of mechanisms is not a cut-and-dried process; and the information given in text-books must be so applied as to fit in with the conditions affecting each designing problem.

The endless variety of combinations and factors relating to the work the mechanism is to perform, the conditions under which it must be used and the operating and manufacturing costs, all tend to regulate or modify designs more or less, and also to multiply the chances either of drafting-room errors or the adoption of plans not representing approved practice. Designers may often derive benefit by studying the fundamental causes of poor designs, as the errors or downright failures frequently make the approved methods stand out in bold relief.

While all designers realize the importance of preventing errors as far as possible, the fact that they can be reduced to a minimum by studying the underlying reasons and by applying preventive methods systematically, is not always appreciated. The word "error" as here used applies not only to flagrant violations of established principles, but to neglect of any elements of design affecting operating results, manufacturing costs, quality of the product, or the reputation of the manufacturer.

* * *

THE HABIT OF OBSERVATION

There are often little deficiencies around a shop that cause more waste of time, in the aggregate, than the loss of a few minutes in the performance of a machining operation. Looking for wrenches to fit a nut or stud is one of these wastes; another is the lack of proper bolts and clamps for planers, milling machines and other equipment where work has to be clamped to the table of the machine. Some men waste time measuring or gaging their work too often, fearing that they will machine it to a dimension below the required size; and while care in this respect is very necessary, experience should teach the man who is observant how soon he should need to begin to gage or measure his work carefully.

A foreman who is a close observer will notice such things and save considerable time in a twelvemonth, that would have been wasted either through a lack of proper tools and supplies or of proper instruction to the operators. One of the important functions of the foreman is to teach. He should know how the work can be done to the best advantage, and should then instruct each man, showing him why he can obtain better results by following certain methods.

But these are all minor results of the habit of observation. Men who pass their lives without cultivating and exercising it usually do not rise above the level of mediocrity. They fail to see and to avail themselves of opportunities that to others lead to fame or fortune.

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THE CHEAPEST CUTTERS COST MOST

In a large plant the superintendent's figures showed that there were enough milling cutters of a certain type in the tool-room to last for a month's production; but in a few days the stock-keeper notified the purchasing agent that his supply was almost exhausted.

The superintendent's investigation showed that the cutters were bought on price—and on price only; that while good cutters of the type referred to would last, in regular production and when properly resharpened, for about two weeks, the teeth in the cutters on hand, due to improper hardening, would sometimes break after a couple of hours' use. The price of the cheap cutters was approximately 20 per cent less than that of the best cutters in the market; but a little figuring showed which kind really cost the most, especially when expensive delays in the operation of the milling machine department were figured in.

The superintendent had some difficulty in convincing the purchasing department that the "cheap" cutters were really the most expensive, and he now keeps performance records of all small tools used, which is the only way the advantage of one tool over another can be determined accurately. Price alone is no criterion, although unfortunately the buying of many plants is based on that.

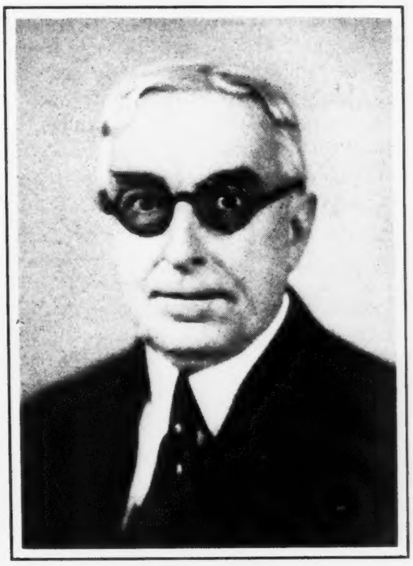
National Metal Trades Convention

THE National Metal Trades Association held its twenty-eighth annual convention at the Hotel Astor, New York City, April 15 and 16. The annual report of the president, Paul C. DeWolf of the Brown & Sharpe Mfg. Co., Providence, R. I., indicated the great activity of the association in many fields. In this report, Mr. DeWolf referred briefly to the improved efficiency in metal-working plants which is accounted for in two ways: First, by closer cooperation between the management and the employes; and second, by improved equipment, more careful studies of manufacturing conditions, and closer supervision. The second phase has, in a great many instances, meant a marked change in equipment and the replacing of a great deal of the older machinery with new equipment of greater productive capacity.

A Review of Business Conditions

A questionnaire had been sent out by the association with a view to ascertaining the business conditions in the metal-working field at present and the prospects for the near future. In answer to the question "How is business?," out of 440 firms, 31 reported excellent; 202, very good; 186, fair; and only 21, poor. In answering the question "How does business compare with six months ago?," 194 reported better; 198, just as good; and only 48, not so good. Answering to the third question, "What is the outlook for the next six months?," 34 reported excellent; 211, good; 190, fair; and only 5, poor.

In this connection, questions were also asked whether labor of any kind seemed to be scarce. The answers indicated scarcity of skilled men. One hundred fifty-six firms reported no scarcity; 142, a scarcity of skilled men; and 29, a scarcity of semi-skilled and common labor.



Paul T. Norton, Newly Elected President of the National Metal Trades Association

In order to ascertain to what extent the firms that are members of the association were endeavoring to overcome the shortage of skilled men, the question was asked, "Do you train apprentices, operators, and foremen?" Three hundred forty-nine replies were received; 240 answered that they train apprentices, 251 that they train operators, and 183 that they offer training to their foremen. Only 91 stated that they do not attempt any training. A year ago the number that reported that they did not train men was 124. Hence, there is an increase in the number of members who are applying themselves to the education of young men to develop future skilled mechanics and industrial leaders. Mr. DeWolf expressed the opinion that the report, nevertheless, showed that the membership, as a whole, is not as yet meeting the situation adequately.

Progress of Industrial Education

In referring specifically to the subject of industrial education, Mr. DeWolf pointed out that marked progress is being made by the committee having this subject in hand, of which J. C. Spence of the Norton Co., Worcester, Mass., is chairman. During the course of the convention, Mr. Spence made some very definite and well thought out remarks on this subject. The committee has prepared a series of texts on "Elementary Machine Shop Practice." These texts are meeting with increasing favor in plants where training courses or apprenticeships are established, and are also used by a number of non-members, schools, and teachers in industrial educational institutions. The major undertaking of the committee this year has been to develop a course in foreman training. This is a difficult task, because it is not easy to obtain the right kind of material or to put it in the proper form.

On the subject of accident prevention, Mr. DeWolf stated that the department of safety engineering of the association, under the able direction of J. B. Doan of the American Tool Works, Cincinnati, Ohio, has made valuable contributions during the year. Safety bulletins for use on bulletin boards have been prepared and distributed among the members, and a study has been made of the application of the safety idea to the existing provisions in the several states, covering the subject of compensation insurance.

Among the many addresses presented to the convention should also be mentioned "Management's Contribution to American Industry," by John W. O'Leary, president of the Chamber of Commerce of the United States. In the course of his address, Mr. O'Leary pointed out that one of the greatest things in business today is the willingness of men to exchange ideas. Management has recognized the futility of single-handed efforts, and many associations are now excellent examples of co-ordination for the welfare of all who are engaged in industry—employers and employes alike.

Ogden L. Mills, member of Congress from New York, spoke on "The Real Tax Problem in the United States," and W. Irving Bullard, vice-president of the Merchants National Bank of Boston, spoke on "The Problems of International Finance." Many other subjects of importance in the entire field were dealt with.

Officers Elected for the Coming Year

The officers elected for the coming year are as follows: President, Paul T. Norton, president of the Case Crane & Engineering Co., Columbus, Ohio; first vice-president, Harold C. Smith, president of the Illinois Tool Works, Chicago, Ill.; second vice-president, J. G. Benedict, president of the Landis Machine Co., Waynesboro, Pa.; and treasurer, J. W. O'Leary, president of Arthur J. O'Leary & Son Co., Chicago, Ill.

Mr. Norton, the new president of the National Metal Trades Association, was born in Elizabeth, N. J., and graduated from Princeton in 1885. He served an apprenticeship in the shops of the Central Railroad of New Jersey, and has since held a number of important executive positions with manufacturing, engineering, and mining corporations in New York, Philadelphia, and the Middle West. He has been president of the Brighton Coal Co., the Cole Engineering Co., the Nassau Coal Mining Co., and the Kilbourne & Jacobs Mfg. Co. The Case Crane & Engineering Co., of which he is now president, operates two factories at Columbus, Ohio, manufacturing electric overhead traveling cranes, railroad bridges, steel frames for buildings, railroad cars, and contractors' and material handling equipment.

For a number of years Mr. Norton has been active in the administration council of the National Metal Trades Association, and for the last four years he has served in the capacity of vice-president. He succeeds as president, Paul C. DeWolf of the Brown & Sharpe Mfg. Co., Providence, R. I., who has served in this capacity for the customary two years.

Proportioning Standard T-slots and Bolts*

By LUTHER D. BURLINGAME, Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

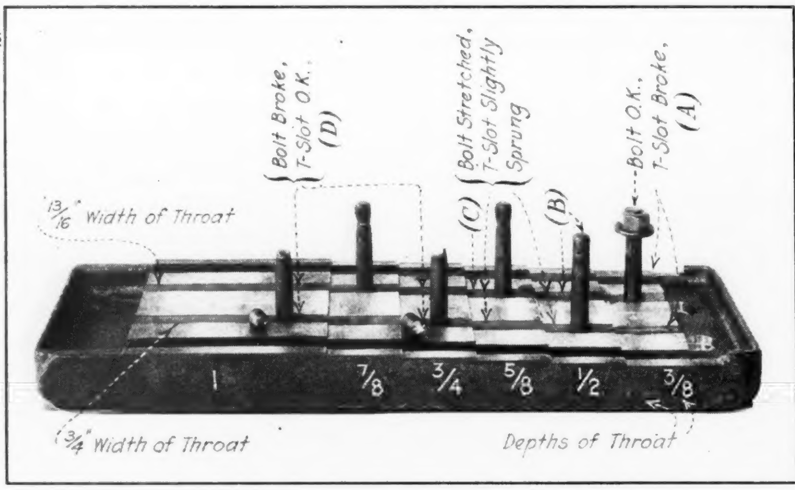


Fig. 1. Results of Tests to ascertain Comparative Strength of 3/4-inch T-slots and Bolts

FOR many years forward-looking engineers have urged the standardization of the holding elements of machine tools, prominent among which are T-bolts and slots. The importance of such standardization has also been recognized by national technical societies, resulting in the appointment of a committee which has been at work for several years on the problem of providing an acceptable standard for T-slots for tables of machine tools. A standard has now been formulated by the committee; in this work, a great amount of material has been collected showing past and existing practice. Tests have been conducted to ascertain the comparative strength of bolts and slots in order that the proportions submitted may be suited to practical needs. The report is supplemented by the following record of the investigations on which it is based.

Factors Determining the Strength of T-slots

The elements of possible weakness which might result in failure and which were investigated are as follows:

1. T-slot
   a. Denting or compressing metal under heads
   b. Springing or breaking lips
2. T-bolt
   a. Deformation or breakage of lips of head
   b. Pulling off of head
   c. Breaking bolt through body
   d. Breaking bolt at roots of thread
   e. Stripping threads of bolt or nut
3. T-nut
   a. Stripping threads
   b. Deformation or breakage of lips of nut
   c. Buckling by bending at tapped hole

Other Factors to be Considered

Working clearances should be such as to give (1) ample space for oil and chips between the head of the bolt or the T-nut and the T-slot; (2) clearance for the body of the bolt to slide freely in the throat of the slot, even if the bolt is of maximum size or the slot is bruised; (3) allowance for regrinding cutters used in machining T-slots; (4) allowance for machining off worn or bruised surface of table.

Methods of Investigation

A study was made of these varying conditions, and correspondence was carried on with manufacturers of machines and users of equipment requiring T-slots; this included a study of standards in use in foreign countries. Also a series of tests was made by using milling machine tables made of cast iron of varying degrees of hardness, bolts of varying tensile strength, and T-nuts with tapped holes for varying sizes of stud.

Milling machine tables made of "hard" cast iron, such as are regularly made by the Brown & Sharpe Mfg. Co. and other milling machine manufacturers for this purpose, were used for one series of tests. An analysis of the composition of these tables is as follows: Silicon, 1.25 to 1.50 per cent; sulphur, 0.11 to 0.14 per cent; manganese, 0.55 to 0.70 per cent; phosphorus, 0.35 to 0.45 per cent; total carbon, 3.20 to 3.60 per cent; and combined carbon, 0.75 to 0.85 per cent.

In the other series of tests were used tables of "gray iron," often called "soft cast iron," with an analysis as follows: Silicon, 1.90 per cent; sulphur, 0.09 per cent; manganese, 0.60 per cent; phosphorus, 0.50 per cent; total carbon, 3.45 per cent; and combined carbon, 0.60 per cent.

The terms "hard" and "soft" cast iron used in this article will be understood to be in correspondence with these analyses. These tests were made at the Brown & Sharpe Works and at the Engineering Laboratory at Brown University.

Each of these tables had two T-slots machined in it. Those for 3/4-inch bolts had the throat of one slot made 3/4 inch wide, while that of the other was made 13/16 inch wide. The tables for 5/8-inch bolts had the throat of one of the slots 5/8 inch wide, and the other, 11/16 inch wide. Each of these tables had its surface machined off in steps so as to provide different depths of T-slots for the purpose of making tests to determine the comparative strength of the bolt and the lip of the T-slot. Fig. 1 shows a table made of hard iron for 3/4-inch T-bolts having a depth of throat varying from 3/8 to 1 inch, by eighths, and illustrates the bolt and slot after the test.

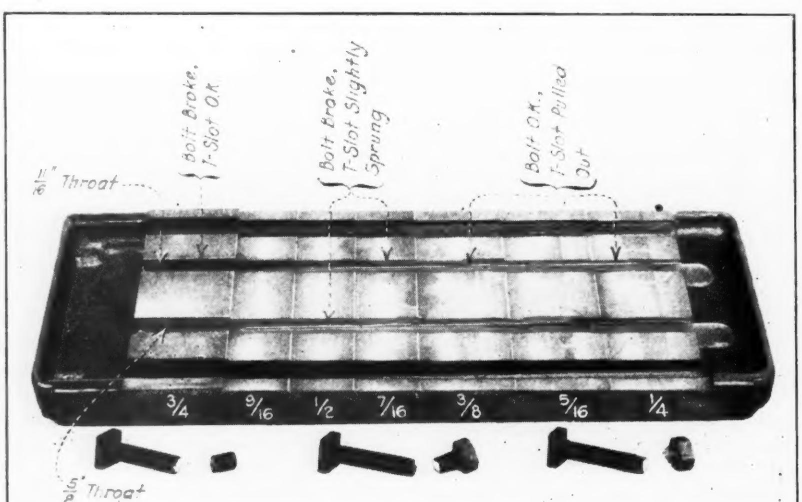


Fig. 2. Results of Tests to ascertain Comparative Strength of 5/8-inch T-slots and Bolts

*Abstract of a paper to be read at the meeting of the American Society of Mechanical Engineers in Providence, R. I., May 3 to 6.

Fig. 2 shows a similar table of hard iron with slots for 5/8-inch bolts, the throats being made 5/8 and 11/16 inch wide, respectively, and the depth of slot varying from 1/4 to 3/4 inch, by sixteenths, up to and including 9/16 inch.

Tests of T-bolts in Tables of "Hard" Iron

Tests were made on these tables by using bolts and nuts of the Brown & Sharpe standard (heads of 3/4-inch bolts, 1 1/4 inches across flats, 1/2 inch thick; 5/8-inch bolts, 1 1/8 inches across flats, 3/8 inch thick; diameter of bolts, 0.024 inch less than nominal diameter for both sizes). The T-bolts were finished from forgings made of No. 2 bolt steel having the following analysis: Carbon, 0.10 to 0.15 per cent; manganese, 0.25 to 0.35 per cent; phosphorus, 0.04 per cent; sulphur, 0.06 per cent; and silicon, 0.15 per cent.

These tests were made with the surface above the T-slots where the strain was exerted unsupported, that is, there was not a clamping "metal to metal." The T-slot was, therefore, left in the weakest condition in this respect in which it might be used.

In order to obtain sufficient leverage to carry out these tests, an extension pipe was put on the handle of the standard wrench, as shown at *A* in Fig. 3. This made it possible for two men to exert destructive force, but the wrench itself would not stand this, and broke in service. A bar of steel *B* with hexagonal openings to fit the nuts, was then substituted. With the latter combination, each test could be carried to the point of breakage either of the lip of the T-slot or of the bolt. In the case of the 3/4-inch bolt with the throat 3/8 inch deep, the metal of the lip of the T-slot was pulled out, the bolt remaining undamaged, as indicated at *A*, Fig. 1. When the thickness of the metal in the table was increased to 1/2 inch the lips were sprung before the bolt gave out, but held sufficiently so that the bolt was stretched and would have broken before actually pulling out the metal, as indicated at *B*.

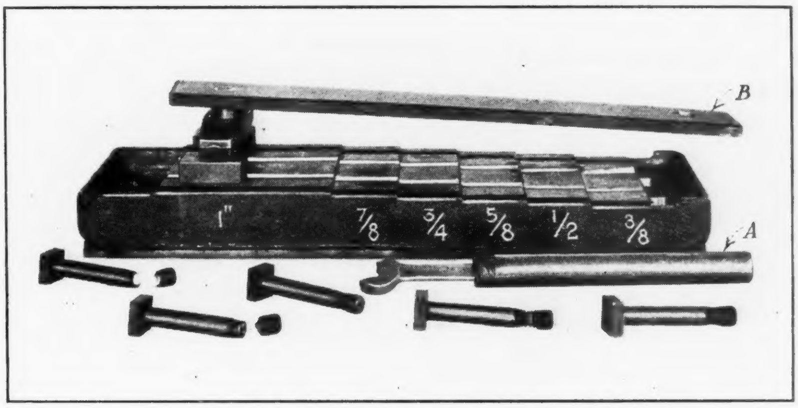


Fig. 3. Method of making Tests on T-slots and Bolts

This, however, was on the border line, and represented approximately equal strength between the bolt and the T-slot. With the metal of 5/8 inch thickness, the bolt was noticeably the weaker element, and stretched, as shown at *C*, while only slightly springing the metal of the T-slot, the latter returning to normal condition as soon as the strain was relieved. With a thickness greater than 5/8 inch, the bolt broke without damaging or even noticeably springing the T-slot, as indicated at *D*.

An effort was made to ascertain whether there was any difference between the strength of the slot finished to 13/16 inch width, as compared with the slot 3/4 inch wide. No noticeable difference could be observed, although in theory the 3/4-inch slot should have been slightly stronger. And in spite of the fact that there is less area of contact between the head and the under side of the lip of the slot, with a 13/16 inch width of throat, there was no indication of denting or crushing of the metal.

Similar tests were made with a 5/8-inch bolt in slots having 5/8 inch and 11/16 inch width of throat. The results shown in Fig. 2 indicate that the T-slot was weaker than the bolt up to and including 3/8 inch depth of throat, but that with 7/16 inch or 1/2 inch depth of throat, conditions were fairly balanced, although favoring the strength of the T-slot in both cases, because the bolt broke before the table was sprung to a degree beyond which it would not recover. With the lips thicker than 1/2 inch, the bolt broke without affecting the T-slot.

Tests were made with studs threaded at both ends for the purpose of learning whether the stud would always break at the same end, either at the upper or lower thread, and it was found that breakage would occur sometimes at one end and sometimes at the other, but always through the threaded portion.

From these facts, it will be seen that in hard iron the thickness of lip of the 3/4-inch T-slot can be a minimum of 9/16 inch, which is practically equal in strength to that of the bolt or stud, while for the 5/8-inch slot a thickness of 7/16 inch can be established as minimum.

Tests on Heads of Bolts

A study was also made of the strength of the head of the bolt. In no case did the head spring or show weakness in other ways. The nuts used with these bolts were of cold-rolled steel 0.10 per cent carbon, 11/16 inch and 9/16 inch thick, respectively. They showed no sign of damage or hard usage due to the tests; neither did their threads or the threads of the bolt on the portion engaging the nuts show deformation.

The conclusion to be drawn is that there is sufficient width of shoulder and thickness of head of the bolts to distribute the pressure on the under side of the lip of the T-slot so as to avoid denting or otherwise damaging it up to the point of rupture of the bolt; later tests showed this to be so, even when the bolt was made of steel of unusually high tensile strength. The further conclusion is drawn that with the throat of the slot 1/16 inch wider than the diameter of bolt, the surface of contact is not reduced to a point where it is objectionable; also that the heads are sufficiently thick and strong to withstand the greatest strain that can be put upon them, before the bolt breaks through the threads.

Comparative Tests Using Hard and Soft Cast Iron for Tables

The tests made to ascertain the comparative strength of T-slots milled in soft and hard iron were made under the direction of Professor James A. Hall of Brown University, and covered both the comparative strength of soft and hard cast iron, and the comparative strength of T-bolts and T-nuts with their cooperating studs. The tests in hard iron showed practically the same results as those already described. Thus for the 5/8-inch T-slot, a 7/16 inch depth of throat provides lips stronger than the T-bolt, which broke under a load of 16,600 pounds.

A noticeable difference between the slots in hard iron and soft iron was that the soft iron not only began to spring, but showed a permanent set, after the removal of the strain, under a lighter load than in the case of the hard iron.

Tests on T-nuts

When the ends of the T-slots are obstructed, or when it is desirable to insert additional holding devices after the work or attachment has been located, the heads of T-bolts are sometimes "slabbed" off so as to allow the bolt to be entered through the throat of the slot, as shown in Fig. 4. This, while a convenient method, is not to be recommended, as it reduces the area of contact of the head with the lip of the slot to such an extent that it soon results in "chewing up" the under side of the lip.

For this purpose, the use of T-nuts is preferable, although here also there is a drawback in that the tapped hole through the T-nut weakens it. If the tapped hole and engaging stud are of the same size as the T-bolt for the corresponding size

of slot, the nut is weakened to such an extent that "buckling" may result and the strain be brought on a limited area of the lip of the slot. The T-nut may "buckle" to such an extent that it will fail by stripping the threads of either the nut, the stud, or both, long before the limit of strength of the stud is reached.

Although for the sake of uniformity, the T-nuts in the report of the committee referred to are listed as using studs of the same diameter as the corresponding bolt, it can be recommended that where maximum strength is desired, the nuts be tapped for the next smaller size of stud, thus giving ample strength to the nut, but reducing the force that can be applied in clamping by an amount equal to the difference in strength between the two sizes of stud. This use of smaller

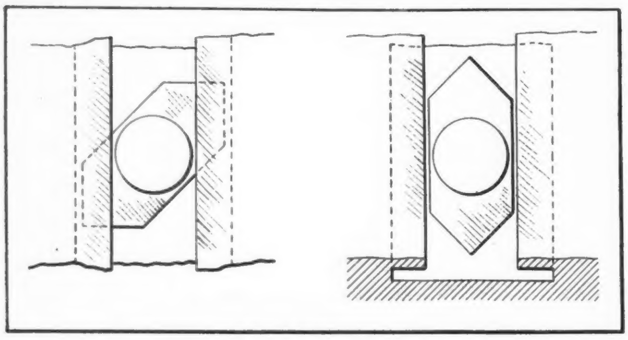


Fig. 4. Bolt Head "slabbed off" so that the Head can be withdrawn through Throat of Slot

studs can be compensated for, in a measure, by using studs having a higher tensile strength.

In most of the tests for T-nuts, the stud, and consequently the tapped hole in the nut, was of the same nominal size as the bolt for the corresponding slot. They showed that the 5/8-inch nuts failed by buckling through the weakened portion tapped for the stud, and that this resulted in stripping the threads before breaking the stud. The condition of the nuts indicated that there was little, if any, added strength obtained from the upwardly projecting portion of the nut, because this portion fractured as soon as a slight bending strain came upon it.

Neither did the greater length of the nut (1 11/16 inches) provide a correspondingly increased length of bearing on the under lip of the T-slot, for when a strain was applied, and before it had reached a point approaching the strength of the stud, the buckling of the nut brought most of the pressure at the center, thus tending to spring the lip of the T-slot under a much less strain than if the load were distributed the full length of the nut, or as compared with the use of a T-headed bolt. This weakness was not so much in evidence for the 3/4-inch nut, in which the stud broke before noticeably bending or otherwise damaging the nut, although if the tensile strength of the 3/4-inch stud had been in proportion to that of the 5/8-inch size, it is probable that the nut would have given out first. The thickness of the tongue portion of the 5/8-inch nut was 13/32 inch, and of the 3/4-inch nut, 9/16 inch.

Comparing the strength of the T-head with that of the T-nut, Professor Hall's tests show that even though the nut is thicker and longer than the bolt head, it is not stronger, if as strong, the limit of the strength of the T-head not having been reached in any of the tests because of the prior failure of the bolt, while the T-nut failed by stripping the thread after buckling the nut; and even in cases where the stud broke first, the T-nut was deformed and its threads damaged before the stud broke.

In the case of one of the 5/8-inch studs, its high tensile strength gave an opportunity to make a severe test on the lips of the 5/8-inch T-slots, 3/4 inch depth of throat, and showed that, even with 30,250 pounds strain concentrated in the line of the stud center, because of the buckling of the nut, the slot was not damaged.

In order to examine the condition of the slots after the tests had been made, sections of the tables were removed so that measurements could be made of the permanent springing of the metal, and a microscopic examination made of the surfaces that had been under pressure. One conclusion drawn by Professor Hall from these tests, relates to the length of the T-nut. An analysis of the distribution of the forces on the T-nut shows that the bending moment at the center must be large, if any considerable pressure is to be carried by the outer ends of the nut. As the cross-section of the T-nut at the center is greatly reduced due to the hole for the stud, the elastic limit of the steel of the nut will be reached at the center long before a normal pressure can be carried by the outer ends of the nut in practice, and practically all of the thrust is taken at the center. It is only after the slot has begun to break that the ends are under any considerable pressure. For this reason, T-nuts would be stronger and more satisfactory if they were shorter.

In all cases where the pressure was not sufficient to crack or break the slot and where the bolts, therefore, broke at the root of the threads, there was no appreciable crushing of the cast iron under the bolt heads, indicating that the crushing strength of the cast iron was not reached.

The Opinions of Manufacturers and Users

A progress report and questionnaire prepared under the direction of the committee were sent out to a selected list of manufacturers building machinery using T-slots, and also to users, and this list was greatly extended through the co-operation of the National Machine Tool Builders' Association. Forty-five replies were received.

While there was a general acceptance of the sizes proposed by the committee, a number of those replying believed that some of these sizes could be eliminated, for example, the smaller sizes, beginning the series with 3/8 inch or 1/2 inch; others suggested leaving out some of the intermediate sizes, such as 5/16, 7/16, and 7/8 inch. The geometrical sizes to which the proposed standard conforms accord closely with some of these suggestions. However, the sale of T-slot cutters indicates that there is a widespread demand for the smaller sizes, so they have been included.

Proportions of Head and Head Space

While the majority of replies showed that the proportions based on the use of commercial T-slot cutters were generally acceptable, those that did take exceptions asked for greater thickness of head and for more clearance space, especially at the bottom of the slot, so that the bolt head would slide freely even when the slot was obstructed by oil and chips, and so as to provide better for the use of T-nuts. A further reason given was that the size of slot should be such as to receive the heads of commercial bolts such as can be obtained in the market.

Conceding that more clearance is desirable, one of two methods for securing this seemed possible of adoption—either to make the heads smaller, continuing to use the commercial T-slot cutters, or to increase the size of the slot, thus requiring new cutters. The latter plan was adopted, and the size of the slot has been increased so as to allow for somewhat thicker heads, especially for the smaller sizes of bolts. This has the objection that some heads of the new proportions cannot be used in present T-slots. For this reason, many manufacturers may choose to continue to make the heads of their T-bolts thinner than standard, using material of sufficiently high tensile strength to insure the desired strength, so that the bolt heads can be used in either the shallower or deeper head space.

The Width of the Throat

It is generally conceded that the throat width is the most important dimension affected by standardization and also the one that is most difficult to standardize because of the importance of interchangeability with past product.

An analysis of the replies to the questionnaire shows the following:

Thirteen favor making the throat width the same as the nominal diameter of bolts.

Thirty-two use (and presumably recommend) a wider throat.

The latter (to which may be added four who express willingness to change) can be grouped thus:

a. Those favoring having the throat 1/16 inch wider than the diameter of bolt, of whom there were twenty-three

b. Those favoring having the small sizes (usually 1/4 inch and 5/16 inch) 1/32 inch wider, and all other sizes 1/16 inch wider, of whom there were nine

c. Those favoring having the larger sizes 1/8 inch or more wider, of whom there were four

The total number of replies came from thirty-four machine tool builders, four machine users, three technical societies, and four professors and mechanical engineers.

Of the thirteen milling machine manufacturers who replied, seven used throat widths equal to the nominal diameter of bolt, and six used wider throat widths. Two of this group expressed themselves as willing to change; this would make five favoring a narrower, and eight favoring a wider throat.

Depth of Throat

The depth of throat is the least important dimension to standardize. Where the slot is used for strapping down work or for any other purpose where the strain comes on the unsupported lips of the slot, a greater depth is required than for clamping down a vise or clamping "dog-bolts," etc., where the parts are clamped together metal to metal.

In cases where T-slot cutters are used, it is desirable to specify a maximum depth, as the length of the neck of the cutter determines the depth that can be milled. Specifying a minimum depth provides a safeguard against venturing on "too thin ice."

Comparison with Foreign Standards

In comparing the proposed American standard with T-slot standardization abroad, the practice in Great Britain and Germany can be taken as typical. Broadly speaking, the fixtures and tools adapted to be used on machines of British make and fitted to British standard T-slots can be used on American machines made to the proposed American standard, without change. This includes the use of holding bolts or holding studs and T-nuts. The reverse of this is also true

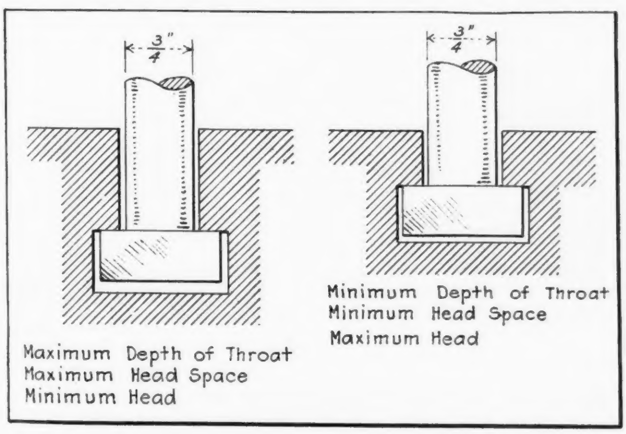


Fig. 5. Illustration showing Maximum and Minimum Depth of Throat and Maximum and Minimum Clearances

—that fixtures and tools adapted to be used on machines of American make and having standard T-slots can be used without change on machines of British make. In some cases, in either instance, reversible tongues might be required, and perhaps spacing washers, to provide for slight variations in length of bolts.

In adapting the standard to machines having metric T-slots, as in the German practice, reversible tongues would be required. In the case of the bolts or studs, however, bolts made to the inch system, Whitworth standard, are commonly used in German practice. Such bolts or studs could be used interchangeably with both British and American standard T-slots.

Determining on a Standard

Having ascertained that proportions such as indicated by the tests here described were in accord with average American practice, and after comparing this with the established practice of other countries, it was decided by the committee to limit the sizes standardized to those listed in the report, which may be obtained from the American Society of Mechanical Engineers, 29 W. 39th St., New York City. This report provides a series approaching very closely to a geometric progression of sizes.

The general demand for a greater amount of clearance space, for more room for chips and oil, and for sufficiently large slots to use commercial bolts and have their heads enter the slots, constituted a sufficient reason in the opinion of the committee for departing from the established standard of T-slot cutters. This was done with more willingness because the simplified schedule of stock cutters adopted in cooperation with the Department of Commerce no longer listed these cutters as standard. It is believed that the proposed sizes should be obtained as readily, and at the same prices, as those formerly listed.

Fig. 5 illustrates the relation of the 3/4-inch bolt to its T-slot by showing both the maximum and minimum clearances, as well as the extremes in depth of throat, and can be taken as typical of the entire series of sizes.

* * *

PROMOTING AVIATION

In a report issued on the general purposes of the Daniel Guggenheim Fund for the Promotion of Aeronautics, the purposes of the fund are briefly summarized as follows: To promote aeronautical education; to assist in the extension of fundamental aeronautical science; to assist in the development of commercial aircraft and aircraft equipment; and to further the application of aircraft in business, industry, and other activities of the nation. The promotion work will be governed by the following principles: It will be restricted to civil activities; efforts will be made to avoid duplication of effort with other aeronautical organizations; work that is properly a government function will be avoided; all work undertaken will be carried through to a definite conclusion; only a simple inexpensive directing organization will be maintained, outside established agencies being depended on to carry out the purposes of the foundation.

Among the specific methods that will be used to accomplish the aims mentioned, the following educational methods are mentioned: Popularization of aviation in schools; lectures at universities; establishment of aeronautical schools; donation of equipment to educational engineering institutions; the promotion of fellowships for studying aeronautics; the instruction of aeronautical mechanics; and the awarding of prizes for papers. In addition, scientific research will be promoted by selecting specific problems and granting funds for fundamental research. In the commercial development field, contests will be held and prizes awarded, inventions will be encouraged, and the economy of the use of aircraft demonstrated. In order to promote the distribution of educational information, it has been proposed to use authoritative popular lectures that will be broadcast and to furnish brief, but accurate, statements to the press. The report gives evidence of definite practical ideas throughout.

* * *

OIL AND GAS POWER WEEK

An extensive national program of meetings was carried out during the week of April 19 to 24 under the sponsorship of a great number of engineering and technical societies, among which was the American Society of Mechanical Engineers. In almost every large center of the country, meetings were held and papers were read on subjects pertaining to oil and gas engines, and the uses of oil and gas in industry. The purpose of the so-called Oil and Gas Power Week was to focus attention by means of simultaneous meetings, discussions, and publicity throughout the country on the recent progress and on the immediate possibilities of the utilization of oil and gas for power purposes. A cash prize of $100 is to be awarded for the best contribution on the utilization of oil and gas for power, presented at the meetings.

MACHINERY EXHIBITS AT LEIPZIG FAIR

Visitors to the fair held in Leipzig, Germany, early in March state that the financial difficulties under which Germany labors at the present time limited to some extent both the number of exhibitors and the number of visitors, so that last year's record was not reached. Nevertheless, there were 10,500 exhibitors in all branches of industry, and 20,000 visitors from abroad, as compared with 17,500 last year. Among the exhibits, few were more representative than those of the German machine tool industry.

The exhibits were grouped in fifteen buildings, one of which was known as the Machine Tool Hall. This building is 600 feet long by 250 feet wide, with a gallery along each side. The ground floor was filled with machine tools, the largest being a horizontal boring, milling, and drilling machine weighing about 80 tons and having a total height of about 30 feet. Accessories of all kinds, such as grinding wheels, milling cutters, gages, and precision measuring instruments were exhibited in the galleries. Most of the machinery was shown under power. Among the tendencies in machine tool design were noted the predominance of independent motor drive and designs of machines with built-in motors. In order to make it possible to show all machines under power, whether motor driven or not, the Machinery Hall is provided with lineshafting running the full length of the hall under the galleries. In that way, belt-driven machines may be shown at an equal advantage with motor-driven machines.

It is stated that the German machines showed many improvements, and that the alertness of the German manufacturer to the progress of machine tool design in America and in England was obvious. The designs were more heavy and rigid than formerly, and greater attention had been paid to finish and general appearance.

Much shop equipment was also exhibited in the buildings reserved for other industries. One building, for example, was devoted exclusively to machines and tools for special purposes, including welding and cutting apparatus, blowers, compressors, wrenches, and belt fasteners. In this building, textile machinery and pumps were also exhibited. The electrical industry had a building of its own. The only important industry that was not represented by an exhibit was the German automobile industry which has not yet satisfied itself that the Leipzig Fair meets its requirements and which therefore continues to hold an automobile show in Berlin. On the whole, however, there is a general tendency to eliminate other fairs and exhibits and to concentrate all efforts upon the Leipzig Fair as the main annual exhibit of Germany. Foreign automobiles—American, French and Italian—were exhibited at the fair.

* * *

PRODUCTION MEETING OF AUTOMOTIVE ENGINEERS

The Society of Automotive Engineers has announced that this year's production meeting will be held September 21 to 23 at the Hotel Sherman, Chicago, Ill., in conjunction with the exposition of machine tools and heat-treating equipment held in Chicago by the American Society for Steel Treating during the week September 20 to 25. Included in the program will be production sessions on conveyor systems and methods, automobile gears of all types, machine tools, and inspection. Two or three factory visits will be arranged, and ample opportunity will be given for inspection of the exhibits at the Steel Exposition. Production men who visited last year's exposition at Cleveland recommended that the society arrange its production meeting this coming fall so that the exposition could be attended at the same time.

* * *

In speaking to his students at Cornell University, the late Professor Sweet emphasized the fact that industry today expects performance rather than knowledge, in these words: "The world will not pay you for what you know, but for what you can do."

TRAINING AUTOMOBILE REPAIRMEN

The Council of the Institution of Automobile Engineers, in a letter recently distributed to the automobile manufacturers and the leading automobile repair shops of Great Britain, emphasizes the shortage of really well equipped automobile repairmen and calls attention to the requirements of the future. In this letter it is pointed out that future requirements should receive attention now and that some scheme of training young men to become automobile repairmen should be undertaken. The smaller shops, which furnish the greater part of the service called for by the public, require great versatility.

The plan proposed by the institution, says the *Motor Trader*, embraces a course of training that will extend over a period of five years and is to be taken at the plant of an automobile builder, in the shops of a large operator of motor vehicles or in a large repair shop. At the end of the course a written examination will be held. The course is divided into both practical work in the shops and class-room work, the latter including drafting and the study of text-books in foundry practice, material testing, blacksmithing, and metallurgy, as well as a study of the parts of a car, their purpose and construction. The outline of the practical portion of the course is as follows:

Subject	Months
Machine shop	9 1/2
Engine testing	2
Car testing	2
Showroom	2
Fitting and assembling	2
Electrical equipment	3
Tool store-room	1
Wheel and tire work	1
Coppersmithing	1
Hardening	1/4
Welding	1/4
Repairs	36

It will be noticed that three years, or the greater part of the training period, will be spent on actual repair work.

* * *

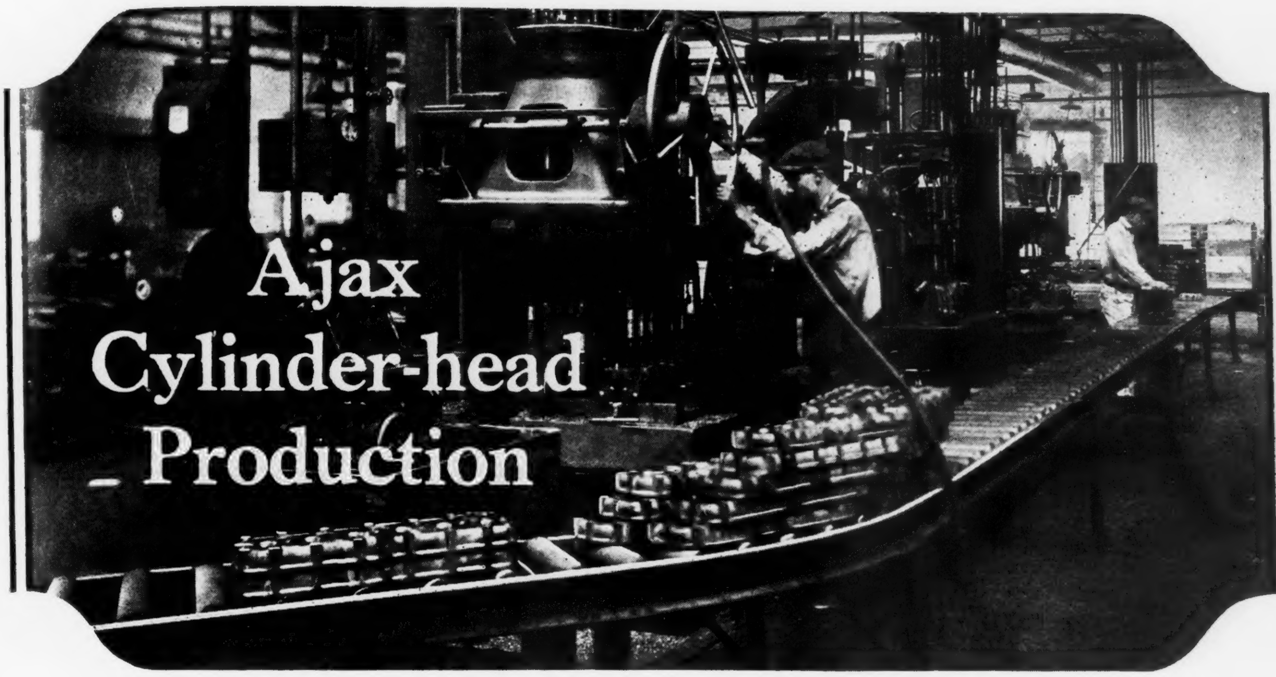
NATIONAL FOREIGN TRADE CONVENTION

The thirteenth national foreign trade convention held at Charleston, S. C., April 28 to 30, was attended by business men from all parts of the United States. At this convention an opportunity was provided for the consideration of the present condition and the future possibilities of the foreign trade of the country. The convention also inspired and fostered cooperation in the successful use of the country's resources, and the opinions of experienced men of practical training in foreign trade was made available in the interest of all present. In opening the meeting, James A. Farrell, president of the United States Steel Corporation, spoke on "The Foreign Trade Outlook." Group sessions were held on the following subjects: Education for Foreign Trade; Banking Facilities for Foreign Trade; Export Sales Policies; Foreign Credits; Export Problems in South America; Markets, Export Managers, and Export Commission House Methods; and Export Advertising.

* * *

ANNUAL MEETING OF GEAR MANUFACTURERS

The annual meeting of the American Gear Manufacturers' Association will be held May 13 to 15 at the Book-Cadillac Hotel, Detroit, Mich. The president, E. J. Frost, will address the association on the subject "The Common Good." Other addresses scheduled for the meeting are "Predetermining Gear Tooth Quality," by J. L. Williamson of the Fellows Gear Shaper Co., Springfield, Vt.; "Wear on Gear Teeth," by Earle Buckingham of the Massachusetts Institute of Technology, Cambridge, Mass.; "America—The Keeper of the Keys," by Charles E. Stuart, president of the Central Steel Co., Massillon, Ohio; "Lifting the Veil of Oil Infections," by W. D. Price, service director of the Warner Gear Co., Muncie, Ind.; and "Are you Using Pre-war Stuff?" by Mason Britton of the American Machinist. In addition, numerous reports will be presented by the various standardization committees.



Ajax Cylinder-head Production

A Machine Line-up that Enables Two Men to Maintain a Continuous Production of One Cylinder Head Every Five Minutes

In planning for the manufacture of the new Ajax automobile, the engineering department of the Ajax Motors Co., Racine, Wis., enjoyed peculiarly ideal conditions. Since every machine in the plant was to be purchased new, the most up-to-date and desirable machines could be selected for the different operations, and the best methods of tooling based on previous experiences could be adopted. Among the various machine lines pointed out with pride in this plant is that used in machining the cylinder head. Two men perform all the operations and maintain a production of 120 cylinder heads per day of ten hours.

Milling Top and Bottom of Cylinder Heads

The arrangement of the group of machines used in finishing the cylinder heads is shown in the heading illustration. Fig. 2 shows a close-up view of the machine employed in the first operation, which consists of rough- and finish-milling twenty-four bosses on the top surface, and rough- and finish-milling the bottom surface. It will be seen that the operation is performed on a continuous rotary type of machine equipped with two different styles of fixtures, one of which is designed to hold the top of the cylinder head uppermost, and the other to hold the bottom uppermost. Obviously the fixtures are arranged alternately; as the cylinder head comes to the front of the machine after the top has been finished, it is reversed and put into the next fixture for milling the bottom. The cylinder heads are then carried to the next machine by a gravity conveyor.

In the fixture used in milling the top of the cylinder heads, the bottom of the work rests on four spring-actuated plungers, two stationary studs, and two equalizing points. Nuts on clamps at the front of the fixture are first tightened to force the clamps against the front of the cylinder head and push it against stops at the back. The spring plungers are next locked immovable by tightening a nut *A* at each end of the fixture. At the right-hand end of the fixtures, considering them as rotating past the front of the machine, there is a stop plug *B* which takes the end thrust of the cutters. In the fixture used in milling the bottom, the cylinder head is located by seating several of the bosses that are finish-milled in the preceding step on three hardened and ground flat strips. Clamps at the front of this fixture are also used to hold the cylinder head against stops at the back.

A feature of considerable assistance in loading these fixtures is the bar *C*, which is attached to a swivel eye at the center of the fixture. On this bar there is a yoke which is forced on a cylinder head by means of the handle after the head has been placed in a fixture, so as to seat it firmly while the operator tightens the front clamps. The bar is counterweighted so that it assumes the position illustrated as soon as the operator releases his hold on it. Both cutters are large enough in diameter to sweep the entire width of the work.

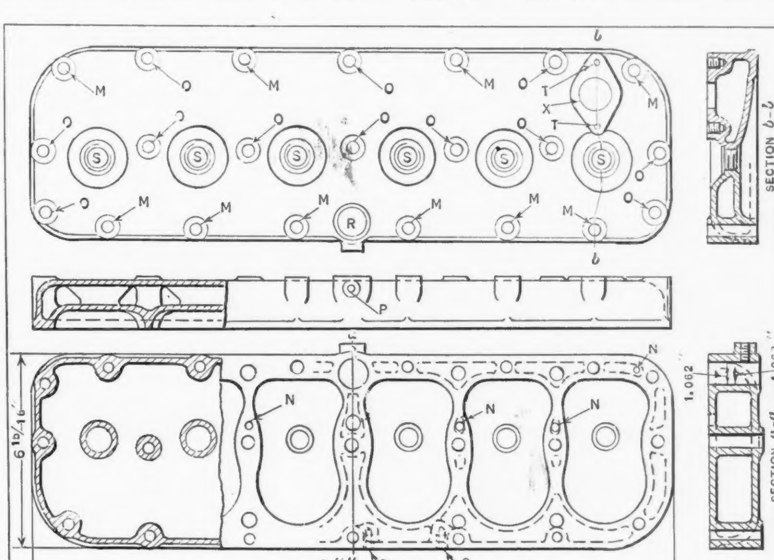


Fig. 1. Cast-iron Cylinder Head used on Ajax Automobiles

A Multiple Drilling Operation

In the second operation, twenty-eight holes are drilled in the cylinder head on the multiple-spindle drilling machine illustrated in Fig. 3, which is equipped with a three-station fixture and two drill bushing holders. The drill spindles are arranged in two groups, the first of which drills ten holes *M*, Fig. 1, which are 15/32 inch in diameter, and six holes *N*, 5/16 inch in diameter. At the end of the first step, the fixture is indexed one-third of a revolution

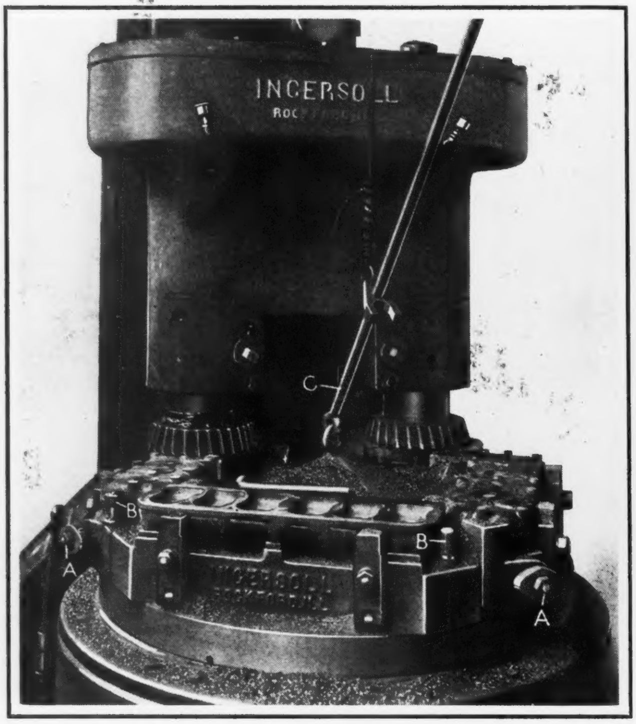


Fig. 2. Rough- and finish-milling the Top and Bottom of Cylinder Heads in a Continuous Rotary Machine

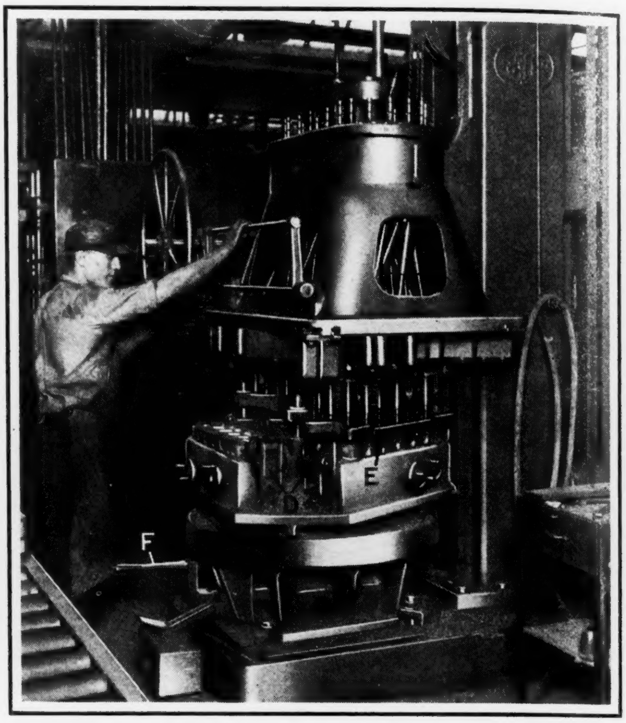


Fig. 3. Drilling Twenty-eight Holes in Two Steps on a Multiple-spindle Drilling Machine equipped with a Three-station Jig

for drilling twelve holes *O* to the same diameter as holes *M*. The cylinder heads are placed in this fixture with the top down, resting on four hardened strips, and with the back in contact with a stop. A link attached to the upper end of a hinged clamp *D*, Fig. 3, at each end of the fixture is dropped on the cylinder head, and then by rotating a handwheel at the front of the fixture clamps *D* are swiveled so that the upper ends move outward and draw the links against the ends of the cylinder head to hold the head secure. Two hook clamps at the back of the casting are also swiveled down on the cylinder head and locked in place by turning the second handwheel on the front of the fixture.

During the operation, the drill bushing holders *E* are supported firmly by studs at the two ends of the fixtures, and are properly aligned with the work by two guide pins on the fixture over which bushings in the end of the bushing holder slide. The bushing holders are lifted from the work by the head of the machine when it is raised at the end of each drilling step. Indexing of the fixture is accomplished by lifting lever *F*, which releases a spring plunger, and then revolving the rotary table by hand.

Two Simple Drill Jigs

The next operation is performed on the three-spindle drilling machine illustrated in Fig. 4, and consists of drilling, spot-facing, and tapping hole *P*, Fig. 1, while the work is held in fixture *G*, Fig. 4, and of drilling and tapping two holes *Q*, Fig. 1, with the work held in fixture *H*, Fig. 4. Fixture *G* is provided with four locating surfaces for the finished bosses on the top of the cylinder head. There are also two stops for locating the head vertically. The head is locked to the fixture by seating cored hole *R*, Fig. 1, over a stud and tightening C-clamp *I*, Fig. 4, over it by means of the thumb-nut shown. A hinged link containing a drill bushing is laid forward on the work for drilling, and then swung back as shown for spot-facing and tapping.

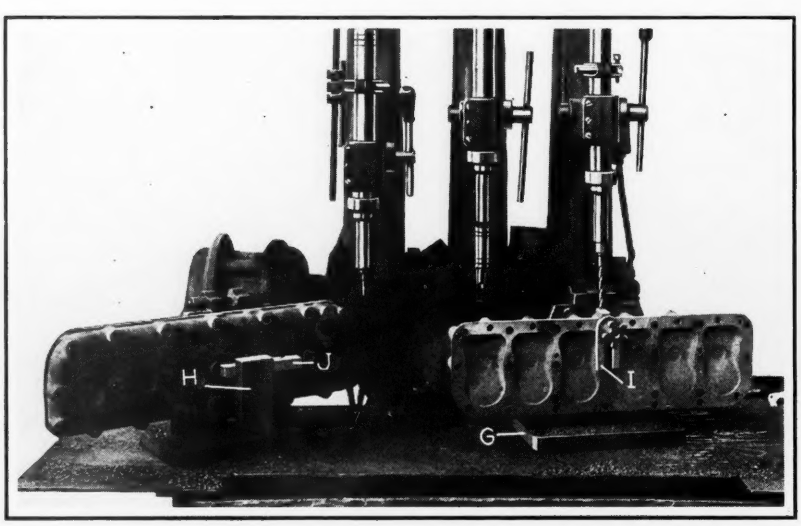


Fig. 4. Two Simple Styles of Jigs used in Drilling, Counterboring, and Tapping Operations

Jig *H* is provided with three pads against which the finished bottom surface of the cylinder head is seated, and two pins or pilots are entered for locating purposes into holes previously drilled in the cylinder head. A rectangular bar *J* is then slipped into a slot in the upright on the front of the jig to force the cylinder head firmly against the pads already mentioned. This jig is also equipped with an overhead hinged member in which there are two drill bushings. Both jigs can be slid easily beneath the spindles of the machine. All operations so far mentioned are carried on by the first man.

Machining the Distributor and Spark Plug Holes

The next operation consists of drilling and reaming the distributor hole *R*, Fig. 1, on the single-spindle drilling machine illustrated in Fig. 5. For this operation the bottom of the cylinder head rests on the hardened strips of a simple jig, and the head is properly located by means of two pilot pins which enter the two holes *O*, Fig. 1, at the extreme ends near the middle of the cylinder head. The jig is provided with a bracket that extends over the hole to be machined. A hole is machined in this bracket to receive bushing holder K, Fig. 5, prior to drilling. When the drilling is completed, the drill is quickly replaced by a reamer, and the bushing holder is removed to permit the reaming of the distributor hole.

Perhaps the most interesting of these operations is the

Fig. 5. Simple Set-up employed in drilling and reaming the Distributor Hole

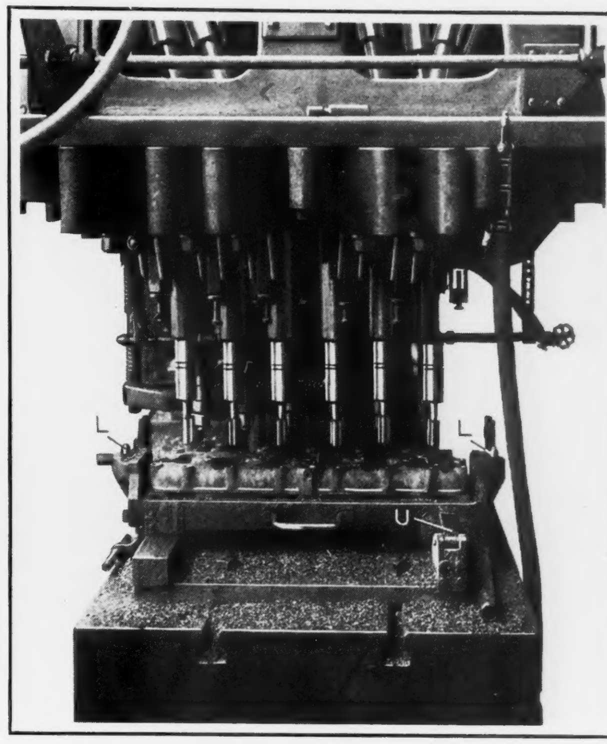


Fig. 6. Drilling, spot-facing, and tapping the Spark Plug Holes in Three Steps

one that is performed next on the six spark plug holes S, Fig. 1, and the two holes T. The spark plug holes are drilled, spot-faced, and tapped, and holes T are drilled and tapped in the multiple-spindle drilling machine shown in Fig. 6. There are three rows of drill spindles equipped with drills, counterbores, and taps, respectively, from back to front. The arrangement of these spindles can be better seen in the heading illustration. The different steps of this operation are performed with three up-and-down movements of the drill head.

The work is seated on a fixture that can be conveniently slid back and forth for positioning beneath the different spindles and for reloading. It slides on one flat and one vee. In this case also, the bottom of the cylinder head rests on hardened and ground strips, and the head is located by means of pilot pins that enter the end holes O, Fig. 1. It is necessary to clamp the work in place for this operation. A jig bushing plate is provided for the group of drilling spindles at the rear of the drill head. At the beginning of an operation, the fixture is pushed back against a stop, and then on the down feed of the drill head, the bushing plate positions itself over a pilot pin L, Fig. 6, at each end of the fixture. All eight holes are drilled simultaneously.

For the second step, the fixture is pulled forward to locate the spark plug holes directly beneath the counterbores. These tools are provided with pilots that seat themselves in the holes just drilled. Finally, the cylinder head is brought beneath the front row of spindles to tap the spark plug holes and holes T. For this step, the work is located approximately by swinging a block U on the V-track, to serve as a stop for the front side of the carriage. Then the taps guide themselves through the holes.

Testing for Leakage and Washing

Sometimes the water in cylinder heads leaks through the walls because of some defect in the castings, such as sand holes. To insure that defective cylinder heads will not reach the assembly line, each head is given a leakage test as it comes from the operation just described. This test is conducted by means of the special fixture illustrated in Fig. 7. The bottom of the cylinder head is held vertically against an upright of the fixture on which rubber gaskets are provided to cover fifteen holes in the cylinder head. The head is pressed firmly against these gaskets by revolving handwheels V to tighten two clamps on the front of the head. Handwheel W is then revolved to tighten a gasket around hole X, Fig. 1, through which water is forced into the head when handle Y, Fig. 7, is operated to open the valve. With a water pressure of 40 pounds per square inch, any leakage is immediately noticed. The fourth, fifth, and sixth operations are performed by the second man.

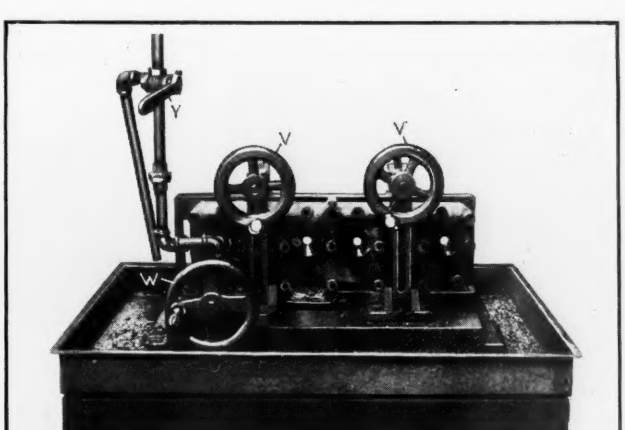


Fig. 7. Special Fixture used in testing the Cylinder Heads for Leakage

At the end of the leakage test, the cylinder heads are run through a large metal washing machine to remove all grease and dirt. In fact, practically every piece assembled into the motors or transmissions is cleaned in this manner before it reaches the assembly line. After being washed, each cylinder head is given a thorough inspection.

* * *

STANDARDIZATION OF WIRE GAGES

A conference was held March 18 in the Engineering Societies' Building, New York City, attended by representatives of twenty-five organizations interested in wire and sheet-metal gages. It was decided that the present thirty odd wire and sheet-metal gages in use in this country cause a great deal of confusion, both in the purchase and in the use of these products, and that efforts should be made to standardize wire and sheet-metal gages. The detail technical work will be in the hands of a committee representing interested industrial groups, working under the auspices of the American Engineering Standards Committee, 29 W. 39th St., New York.

Detailed Costs in the Machine Shop

Starting or Remodeling a Cost System to Get Costs of Details—First Article

By JAMES ALLEN THOMAS

NO attempt will be made in this article to map out a plan for a working cost system; that must be done by the head cost accountant. But a few of the salient features of a good system for keeping detailed costs will be given, with some suggestions as to what should be attained and the way to attain it. There may be many ways to obtain the desired result, but the shortest way is usually the best. It would be impossible to map out a system that would cover all cases, and it would take a good deal of space to cover even one case; therefore, this subject will be treated in a general way only.

There are factories that have cost systems that, with a little refinement and a few changes, would give all the results referred to in the previous articles in this series. There are other factories with systems that would give all the information referred to, if it were taken out and recorded or compiled into shape for use, but in some of these cases it seems as if the management had never realized the possibilities of saving that would result from such uses of the information.

Cost of a Cost System

It may seem at first glance that the cost of running a cost system that gives such detailed information would be prohibitive, and would add too much to the overhead of running the business. However, the savings in production costs that it will lead to will many times offset any additional expense, if it offers no other advantage. The additional cost of operation in order to compile such data is surprisingly small. When the stationery is correctly designed, the routine of the system properly planned, and the different operations of accounting performed in the correct sequence, the labor involved is insignificant in comparison with the results obtained. Like any other work, to be efficient, it must be systematically and intelligently done.

The fewer the number of printed forms employed, the better, and the size of these should be standardized as far as possible. All of the information that can be printed on the forms should appear there, leaving as little to be filled in as possible. Such forms as time slips, orders for material, etc., should be particularly simple in their wording, so that they may be easily understood and filled out by people who are not familiar with clerical work. The name of the company on any of the forms used is superfluous, and is even dangerous if it appears on some of the more important forms, as they might be lost or stolen and get into the hands of a competitor.

All orders for material and work should emanate from a central order department which operates between the engineering or designing department and the shops. All records of labor should originate in the shops and go through the paymaster's department to be priced, and then to the cost department. All records of material used should go direct from the warehouse to the cost department. The warehouse should price them.

The cost department compiles all the information and puts it in form for future use. The cost accounting work must be planned so that the operations follow each other in a manner to facilitate work. There must be no lost motion or going back over the work a second time to compile some detail of information that could have been secured as the process of making up the cost records advanced. The information must be taken out in proper sequence. The working of the system becomes a sort of automatic or evolutionary process. Correct planning of the work will permit the most infinitely detailed costs to be obtained readily.

Personal Qualifications Needed in Cost Accounting

When the cost system is operated in a systematic manner, it will be found that the cost of operating it will be less than when this is not done. The more complicated the system, the more intelligent the operatives must be. One requisite is to have at the head of the system a person who has a pretty fair idea of what the costs pertain to. He should know something of mechanical terms and names of the materials used and the conventional names of parts. It is very useful to him to be able to read drawings, and he should have what—for want of a better name—might be called "mechanical sense." The more he knows about machinery and shop practice of all kinds, even in a superficial way, the better he is fitted to run the cost system.

It is a mistake to put the cost system in the hands of a bookkeeper, ordinary accountant, or clerk, unless he has had some mechanical experience or possesses mechanical sense. A wide awake cost clerk who understands his business will discover a great many shop leaks, and by reporting them, can do a lot toward increasing the efficiency of the shop. He will also soon find out what leaks, and when and how often it will be expedient to report. Bookkeeping knowledge is not essential to good cost keeping, and in these days of calculating machines, dexterity in figuring is of secondary importance. It is of much greater importance that the operatives have enough knowledge of shop work and materials to enable them to detect glaringly incorrect charges, either of time or material.

The benefit to be derived from a cost system depends very much upon the person at its head. He can largely make it a profitable or a losing venture, and to a great extent, the cooperation of the heads of the departments depends upon his tact and his ability to display some knowledge of the business and thereby command the respect of those with whom he has to work. Being the head of the cost department is a big job in itself, and it is a mistake to put anyone in charge of it unless he understands the business he is keeping costs for, or is able to learn it rapidly. It is usually a thankless task for everybody but the management and owners, and it is thankless for them until they commence to appreciate the benefits to be derived from it. On account of the amount and variety of knowledge required, it is a mistake to think that the cost accountant is just a bookkeeper. He is a whole lot more. The head cost accountant should rank along with the head of any other department.

Getting Cost Data of Practical Value

There are many ways of gathering the information that is necessary for the proper compilation of costs, and the details of the system have to be worked out to suit the individual case. Ideas gathered from observing the workings of some established cost system will serve as a general guide. In starting and planning a cost system, the cooperation of someone from the operating department, engineering department, and estimating department is important. The order department that receives orders from customers, and the clerks who fill out manufacturing orders that are issued to the shops, must also be considered in devising this plan. All these departments have work that must dovetail into the operation of the cost system in order to make it complete and work in a smooth efficient manner.

It is evident that some cost accounts will be compiled, the details of which will have but little future value, but in order to have a real system, this cannot be avoided. When the system is once mapped out, it must be adhered to in all its details, and nothing must be left to the discretion of anyone to permit alterations or curtailment of "red tape." If the system is not adhered to, the whole works will be thrown out of gear.

In the average plant manufacturing a general line of machinery, particularly of the heavier classes, it will be found that the quantity of useless cost accounts will be small, and and these accounts will be mostly for small amounts. All cost accounts of any size and consequence are likely to come in handy at some future time, as some of the details can be used as a standard for future work and as a guide for estimating on work.

Relation of Bookkeeping to Cost Accounting

Absolute accuracy in keeping costs is not attainable, and mathematical accuracy is of secondary importance. These remarks will not be in line with the ideas of expert accountants, but there are reasons for making them. A balance of costs with the regular accounts of the factory is unobtainable without making adjustments in the cost accounts in order to make them balance with the regular books of accounts. This fault is inherent in any system of keeping costs where the overhead is added, and there is no way to correct it. It entails a lot of labor in order to get such a balance, and so far as practical use is concerned, it is of little if any value.

The customary set of books of accounts is always kept, and the accounts will balance within themselves, but there is no plausible reason for trying to make the individual job costs and the account books balance. If it is considered desirable or advisable to try to make the total cost account balance with the general accounts, it may be done by making the necessary adjustments, but as previously stated, the result will be of little practical value. The result of making this balance will show whether or not the rate of overhead has been too great or not enough to cover the overhead expenditures.

There is bound to be a discrepancy between the results of these two systems of accounts, no matter how accurately they have been kept. This should not be disturbing. If the rate of overhead is not changed to adjust this, the discrepancy will gradually be eliminated as the amount of productive hours and the overhead expenditures approach the normal working conditions. The customary system of apportioning the overhead to the different jobs and items of cost precludes any possibility of making the two sets of books balance without periodical adjustments of some kind to the cost accounts. When the necessity of these adjustments becomes evident, it is too late to make them without opening up a lot of back cost accounts in order to correct them and adjust them to the changes in the overhead, and this would produce no profitable result.

When the practice of making overhead adjustments to absorb abnormal amounts of expenditure is followed, the resulting rate of overhead expense gets the excess from a previous period, and it is reflected in the costs of current and subsequent work—not in the costs of the work that was done at the time the abnormal amounts were spent. This statement is based on the assumption that there is a considerable amount added, which will have the effect of increasing the rate of overhead to be added to the wages.

On the other hand, suppose that the amounts added have increased the overhead abnormally, and such a rate of overhead has been added that the cost accounts sum up to something above the total expenditures. What can be done to correct the condition that has been created? Either it must be allowed to go along and gradually flatten out in time, or the excess must be subtracted in order to make the account books and the cost books balance. The result will be nothing but a forced balance without any check-up, and therefore of no practical use.

If it is desirable to add and absorb some abnormal amount of expenditure or make an adjustment of the overhead, it must be done in such a way that the rate of overhead will not be radically inflated. If it is necessary to deduct a considerable amount which has accrued because the rate of overhead has been too great, it should be done in such a manner that it will not lessen the rate of overhead too radically. Thus we come back to the principle that the rate of overhead should not be permitted to fluctuate to any great extent. The way to avoid this is to make this calculation over a long period of time. This will keep the rate of overhead as uniform as possible.

The total amount of hours and the wages paid may be very easily made to balance for all the work done in the shop, and as a check, it may be considered by some, particularly an expert accountant, a necessary thing to do. It will not entail a great deal of labor. Under any system of timekeeping, the time cards will be checked and balanced by the timekeeper's and the paymaster's departments, and this should be sufficient. Even if the time charged to orders and the wages paid balance perfectly with all other accounts, that does not prove that the time has always been charged correctly to the proper jobs or pieces. A cost account can only be as correct as fallibility will permit, and there are a lot of opportunities for mistakes to creep in, with no such facilities for discovering them as obtain in the modern bookkeeping system of accounts.

Establishing a new cost system or changing an existing one is likely to meet with some opposition from various sources and for various reasons, and the absolute support of the management must be had. Armed with this support and the exercising of a little tact and diplomacy on the part of the head of the cost department, the opposition will soon be overcome. After the system is in working order and the heads of departments begin to realize the great value of it, the opposition will cease and hearty cooperation follow.

A continuation of this article will deal with the use of detailed costs in shop management and in estimating.

* * *

EDITORS DISCUSS PATENT MATTERS

The national conference of business paper editors met in Washington recently for an informal meeting with Secretary Hoover of the Department of Commerce. Preceding this meeting the editors discussed matters relating to the present patent situation on the basis of a consensus of opinion obtained from the industries represented by the trade journals. Among the points of dissatisfaction with the present patent situation was mentioned the lack of protection afforded inventors and the industry, because the validity of a patent is determined only by litigation, and too many invalid and worthless patents are granted. The lack of sufficient appropriations for the Patent Office also creates delays in issuing patents, applications being held too long in the Patent Office.

The following specific suggestions for improvements, based upon opinions obtained from manufacturers, engineers, and inventors, were made:

1. Increase the number of examiners so that each may work more thoroughly. Improve their quality and reduce the turnover by paying much better salaries.
2. Increase the Patent Office initial fee and establish a system of progressively increasing annual fees during the life of the patent.
3. Afford public access to applications, say two years after filing.
4. Date patents from time of application instead of time of issue.
5. Provide a simpler and more scientific classification of patents in the searching division.
6. Create a competent Patent Court of Appeals to handle patent litigation, whose decision shall be final.
7. Provide a method for administering the patents of Government employes, that will avoid the present conflict with industry.

Design of Lathe Centers

Typical Designs for Different Classes of Work—First of Two Articles

By FRED HORNER

THE first lathe centers date back to a period of remote antiquity when the tree lathe was invented by one of our primitive ancestors. Just a couple of pointed spikes lashed to two tree trunks situated a convenient distance apart constituted the lathe, and there is little doubt that these early centers were of hard wood, in view of the scarcity of metal and the difficulty of forming it to the required shape at that time. A better result was secured when the centers were put through holes in the trees, instead of being tied to the outside. Hence the heads of the modern lathe are a gradual development from living trees and stumps in the ground to heads fixed on a bed, which led to the use of a treadle gear and, finally, a power drive.

It is interesting to note that the primitive centers were dead centers, as distinguished from the later type of live center developed when the running spindle was invented, and yet the most exacting practice still demands dead centers to be used for much precision turning, screw-cutting, and grinding. The only essential difference between ancient and present methods is that in the former, a cord was wrapped around the work to rotate it, while a power-driven pulley is now used to turn the work by means of a dog.

The introduction of the live spindle enabled chucks of various sorts to be employed, and the center was of necessity made removable. The back or tailstock center remained solid; in some cases, it was merely a piece of pointed rod adjusted in a plain hole in the loose head, and secured with a wooden wedge. Later a screw with the nose pointed was used—a type it is still possible to find on some small low-priced lathes.

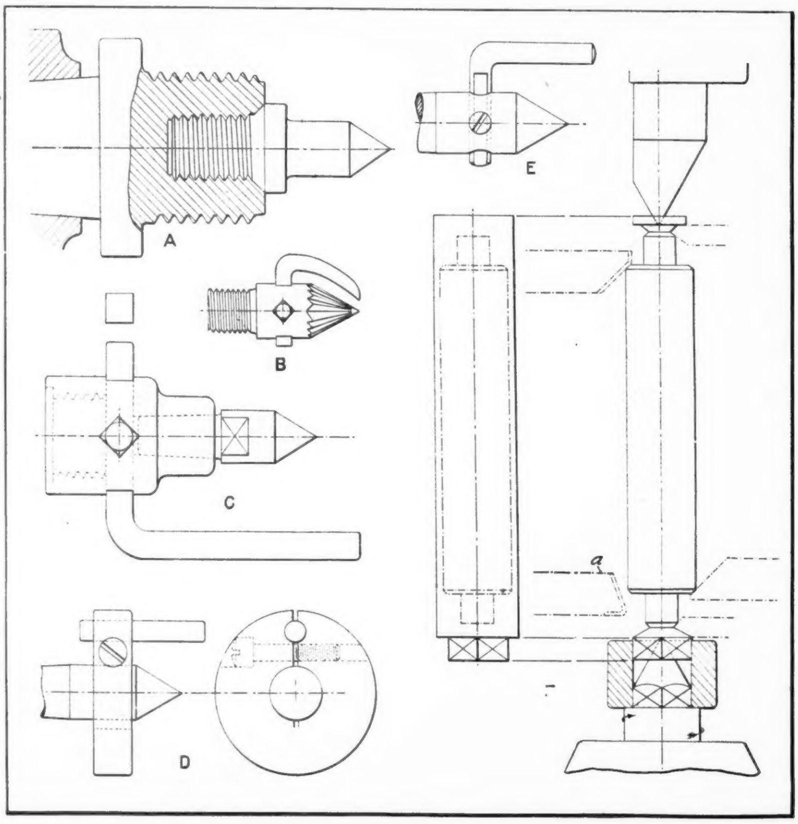


Fig. 1. (A) Threaded Shank Center used on Lathe of Early Design; (B) Fluted Center for Driving; (C) Driving Chuck with Center; (D) Disk and Pin Drive for Small Work; (E) Pin Drive for Small Work; (F) Driving Center used on Automatic Machine

Threaded Centers

For some years after separate centers came into use, they were threaded and screwed into place. These centers had a square shoulder which made contact with the spindle face. This was not a very exact means of locating, even with the best of screws available, but it was near enough for the relatively rough class of turning then done. The centers were soft, and were turned up as they became worn out of true. It is interesting to note that later on, the live center was left soft, as it was subjected to no running wear, while the tail-center on which the work revolved was hardened. Some attempt at improving the concentric fit was made by including a short taper at the mouth of the threaded hole, such as shown at *A*, Fig. 1. This design was used on a Whitworth lathe of early design. A tapered fit, without the screw thread, in the modern way, was next developed. Practically the only place the threaded fit still survives is in the ancient home of the brass-finishing industry, at Birmingham, England, where numerous special lathes are built for turning and polishing pipe fittings and other work of a like nature. The spindle nose is threaded to receive not only plain centers, but also centers with special driving devices and a variety of rather small and simple chucks called "clams," mostly of the two-jaw pattern, which can be more readily made and fitted by a threaded shank than by any other method. As no external thread is required, overhang can be reduced by making the spindle with no projection beyond the bearings, except a fraction of an inch to allow the chucks to clear the headstock face.

Centers with Driving Arms

The special center shown at *B* has flutes which enable a drive to be obtained in the mouth of a cast hole, while performing certain operations. For other operations, a positive rotation can be obtained by inserting the bent driver, which is designed to make contact with a flat or lug on the work. A similar arrangement which at one time was used to a considerable extent for small work is shown at *C*. This type consists of an ordinary center, as shown, or of a hollow pattern and a driving arm, which is extended just far enough to catch the small dog clamped to the work or some suitable part of the work itself.

The friction of a tapered shank center is not sufficient for a heavy drive, but small jobs can be done with some kind of pin or catch-plate, such as shown at *D* or *E*; such arrangements are suitable for bench lathes.

Square Hole Centers

In a new six-spindle vertical automatic chucking machine developed by Thomas Ryder & Son, Ltd., of Bolton, England, the center is designed to do all the driving. One kind of center work for which this machine is used is the turning of rollers for cotton spinning frames, which are about 4 3/4

inches long, and range in diameter from 3/4 inch to 2 inches. In order to enable these to be turned with the least waste of material, they are cast to the outline shown in full lines at the left-hand side of view *F*, with a squared end at the bottom. The dot-and-dash outline shows the finished form.

The lower center is squared for a short distance, and carries a square-hole collar, which engages the work and drives it during the machining operations, forming practically no obstruction to the tools, and leaving only a small amount of scrap. A number of turning operations are performed on this piece, but the view at the right only shows the tool set-up at the final station, in which the tool *a* finish-turns the body, and the chamfering and necking tools perform the operations indicated.

Occasionally large driving centers are employed, which fit the bore of a forging, such as a shell, for instance. These are made with three hardened strips fastened to the sloping portion, which engage the mouth of the cavity in the work. However, this construction is adopted only in the case of centers that are sufficiently large to have a hub that can be threaded to fit the spindle nose of the lathe.

Taper-shank Centers

For nearly all purposes except the brass work previously mentioned, the regular practice is to depend on taper shanks to hold the centers in both the headstock and tailstock spindles. Most firms use the Morse taper, although some manufacturers are now adopting the Jarno taper. A different class of tapers exists, of course, in the headstock spindles of precision bench lathes, which have to be made to a steeper angle in order to compress the spring collet chuck jaws. The spindles and centers of these machines are generally designed along the lines shown at *A*, Fig. 3. This view shows the extended shank of the center which is threaded to fit the draw-back tube. Sometimes this kind of fitting is modified by extending the nose out to take a thread for a small catch-plate, the center being fitted with a Morse taper. At *B* is shown a simpler method—that of forming the center and the catch-plate in one piece—the shank having the same class of fit and draw-in device as the center shown at *A*.

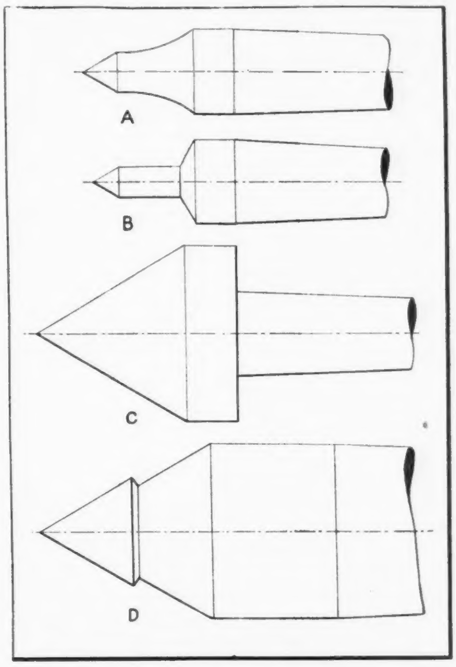


Fig. 2. (A) Reduced Head Center designed for Strength; (B) Reduced Head Center of Usual Design; (C) Enlarged Head Center; (D) Center with Reduced Bearing Surface

Methods of Removing Centers

The usual practice in extracting a tailstock center is to turn back the handwheel until the center end strikes the nose of the screw and is ejected, while a rod passed through the headstock spindle affords a means of driving out the live center. In order to simplify these operations, many centers are flatted, squared, or machined to a hexagon shape for a short space just back of the conical point in order to permit them to be twisted with a wrench. In the case of some lathes in which neither spindle is bored through, and it would be difficult to apply the twisting method, a draw-out nut is employed, as shown at *F*. At *A*, Fig. 4, is shown another arrangement employed on large lathes. In this case, a rod is placed at the rear of the center. By hammering a suitable drift down through the transverse hole against the end of this rod, the center can be forced out.

A special drift, as shown at *E*, Fig. 3, is employed to remove the head center of the "Lo-swing" lathe. The center of this lathe fits in a blind hole, and has a transverse hole for the balanced driver. To remove the center, the driver pin is withdrawn, a shouldered plug put in its place, as shown, and a wedge dropped in and struck a blow with a soft-faced hammer. This loosens the center so that it can be removed when the wedge and plug are withdrawn.

An ordinary cross drift, such as is used for ejecting shanks and sleeves from drilling machine spindles, is sometimes applied to tailstock spindles, as shown at *C*. This arrangement saves time, especially when the spindle happens to be well extended, as it eliminates the necessity of turning the handwheel to bring the screw end in contact with the center. On bench lathe open tailstocks, in which each spindle is simply lifted out of its half bearings to insert a new spindle, there is an opportunity to use a drift pin, as shown at *G*, a cross-hole being drilled as shown.

Angle of Point

The 60-degree included-angle center point which is now practically universal was at one time considered suitable only for light and medium work. It was believed that heavier work required a steeper angle for the center point, but this idea has been proved erroneous. Heavy weights are now carried on centers having 60-degree points. Almost the only exceptions to this standard angle are those necessitated by the somewhat unusual cases in which the work has a special angle for the center recess, as sometimes happens in bench lathe and turret lathe work. Some of the loose revolving centers for special work have different angles, as indicated at *D*. In this case, the center is used to support a tube having a slightly tapered mouth.

Centers with Modified Points

A few remarks on variations of the simple point may be prefaced by mention of the stepped pattern, shown at *D*, Fig. 2, which is designed to lessen the work of truing up, it only being necessary for the grinding wheel to be traversed lightly over half the length of the tapered portion to insure concentricity. The reduced and the enlarged points are in great demand for small and medium lathes. The reduced points are a great convenience in machining fine work, as they allow the tool-blocks or holders to clear the center. The enlarged centers are used primarily for supporting hollow work. At *A* is shown a reduced point, designed for strength. The radius, however, does not always give sufficient space, and the parallel shape shown at *B* is generally considered a better design. The large head *C* serves many purposes on the bench, engine, and turret lathes, being often carried out on an extension holder when used on the turret lathe. In some cases, extra capacity may be gained by slipping a collar over the center, as indicated by the dot-and-dash lines at *B*, Fig. 4.

Lengthened points are essential in some instances to suit special methods of chucking or driving, as, for instance, in machining awkward shaped castings or forgings having projections or arms. Sometimes the driving agent fits closely around the center, and sometimes it is actually rested on it to secure rigidity, while in other arrangements the center is not held in the spindle, but instead is mounted in the special driver or chuck, which may stand out a foot or more from the spindle nose.

The unusual design shown at *E*, Fig. 4, is used on a shaft-turning lathe made by Tangyes Limited, Birmingham, England, in connection with a three-tool rest, having two tools at the front and one at the back. With the special arrangement of heads and centers used, the shaft can be machined completely without being removed from between the centers. The headstock and tailstock are much alike, except that the spindle of the latter has the necessary handwheel adjustment and can be racked along the bed. Each spindle has long centers and driver-pins to suit, these being fitted in compensating or equalizing plates. A shaft along the inside of the bed carries

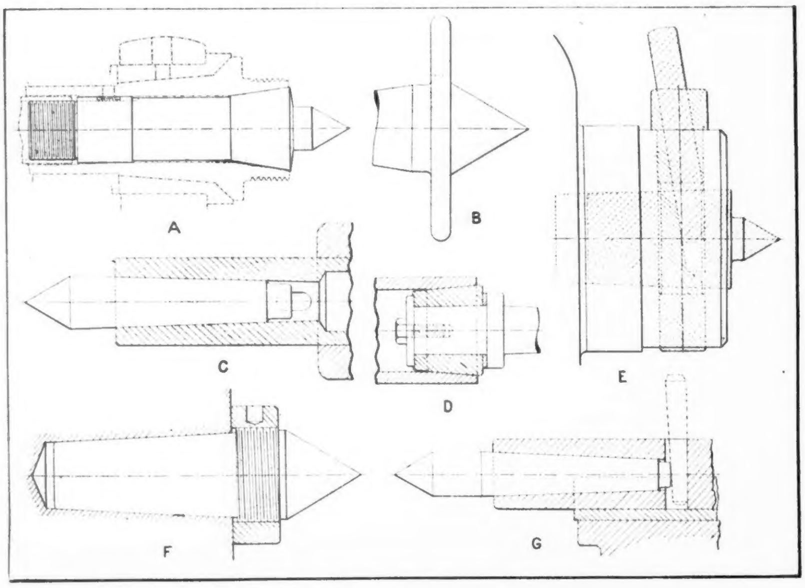


Fig. 3. (A) Center Chuck for Bench Lathe; (B) Combined Driver and Center Plate; (C) Center Spindle with Drift Slot; (D) Revolving Center with Slight Taper; (E) Center with Special Drift to facilitate Removal; (F) Heavy Lathe Center with Extracting Ring; (G) Half-open Tailstock with Cross-hole

pinions which engage gears on the faceplates, the latter being mounted on spindles running inside the head castings and around the dead centers. By making these centers long, the three-tool rest can be drawn back far enough to permit starting a cut on the shaft end, the condition being different from that of a single tool only.

In starting to turn the shaft, the driving is done at the fixed head end, the plate on the loose head being allowed to remain idle. After the carriage has been run up as far as practicable, the fixed head drive is disengaged, the loose head drive engaged, and the dog transferred to the tail end of the shaft, thus enabling the tools to pass beyond the other end of the shaft. This particular lathe has a maximum distance between centers of 25 feet.

Shortened Centers

Shortened centers are employed in special cases, being mostly of the stump type—that is, the cone is not carried to a point, as only the bearing part near the largest diameter is required. Some of these are used for hollow work, while some recent types are made to suit special arbors of rigid design, like that shown at *C*, which is used on the Fay lathe. In this case, the center on the spindle face is centralized by a short hub extending into the end of the spindle. The shortened center extends into the work-arbor which is of the expanding type designed to hold airplane engine cylinders. The two driving pins catch in slots in the arbor. This arrangement provides great rigidity and driving power. The work-holding methods used on the Fay lathe are a distinct departure from common practice as regards the shape of the arbor ends. In one design the tailstock center supports the end of a cone fitted to the spindle. This design, which is shown at *D*, gives a minimum amount of overhang and maximum stiffness.

Cut-away Points

The well-known cut-away point center is set in the horizontal plane for filing and polishing operations, as shown in the upper view at *C*, Fig. 5. For turning or facing operations, it is set in the vertical position. This type is often used, with an extension holder, to support long pieces in the turret lathe. Recently the intensive cutting methods employed on automatic center lathes have led to more cutting away of the center or flatting on each side, as shown in the lower view at *C*. Sometimes one side is flatted more than the other, and often a piece of the tailstock spindle is cut away as well, to let a holder clear, or a piece of the tailstock casting may even be cut away at the front or the top.

A plan view of the Porter-Cable cut-away tailstock is shown at *D*. With this tailstock, a gang of tools may be used on work as small as 5/16 inch in diameter. This tailstock is arched over from the back of the bed, so that the tools can be run past without drawing them back from the work. The Pratt & Whitney 1-inch by 18-inch automatic lathe has a flat-faced spindle of the shape shown at *A*. The center is also flatted, and space is provided at the rear for driving out the center. The "Lo-swing" lathe has a center, shown at *B*, which is fitted in a spindle having three facets, the lower one receiving the upward pull of two clamps that bind it in its half-circular seat in the footstock after the handwheel is adjusted. The carriages and tool-holders on this type of lathe are of such a shape as to correspond closely to the resulting profile of the casting, spindle, and clamps.

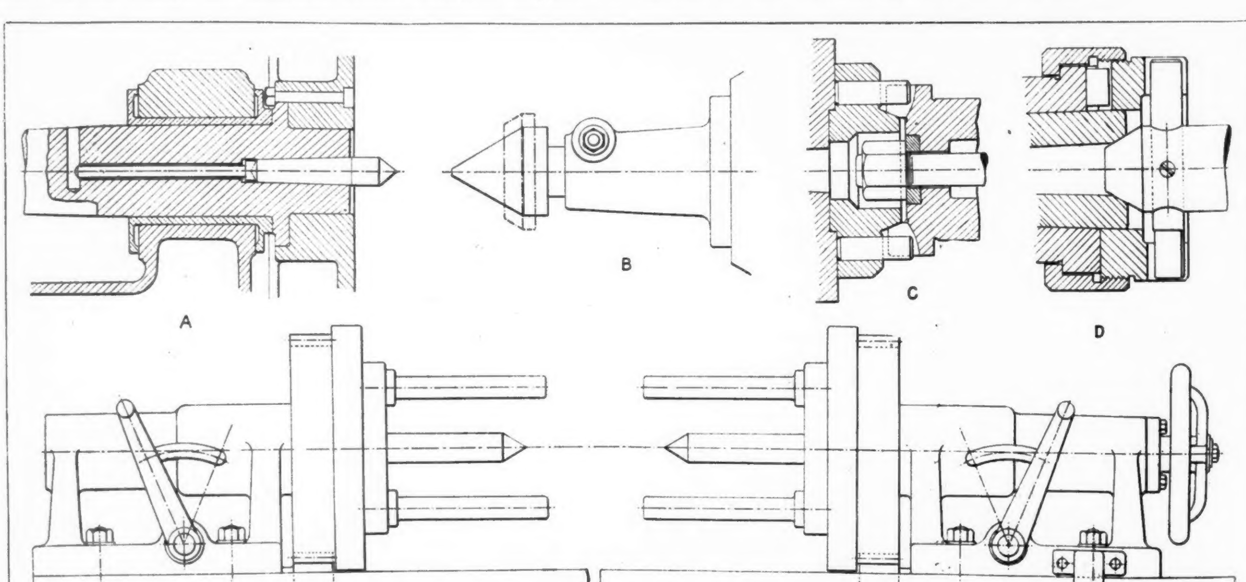


Fig. 4. (A) Center provided with Plug Ejector; (B) Enlarged Center for Turret Lathe with Extra Capacity Ring; (C) Stump Center and Driver; (D) Arbor with End formed as Center; (E) Shafting Lathe arranged for Drive at Either End

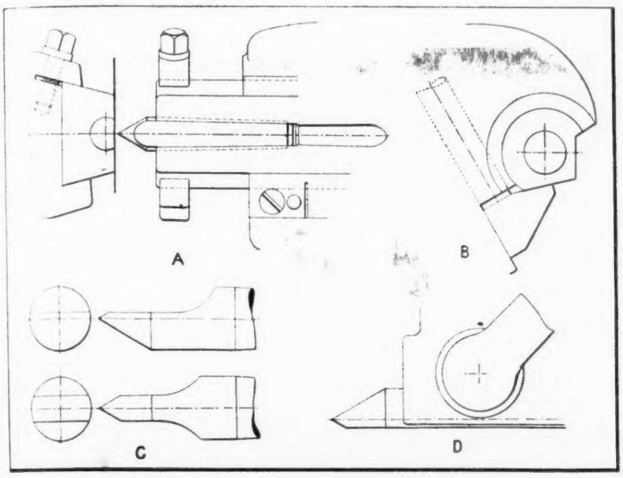


Fig. 5. (A) Flat-faced Spindle and Center of Automatic Lathe; (B) Center used on "Lo-swing" Lathe; (C) Cut-away Centers; (D) Flat-faced Pipe Footstock

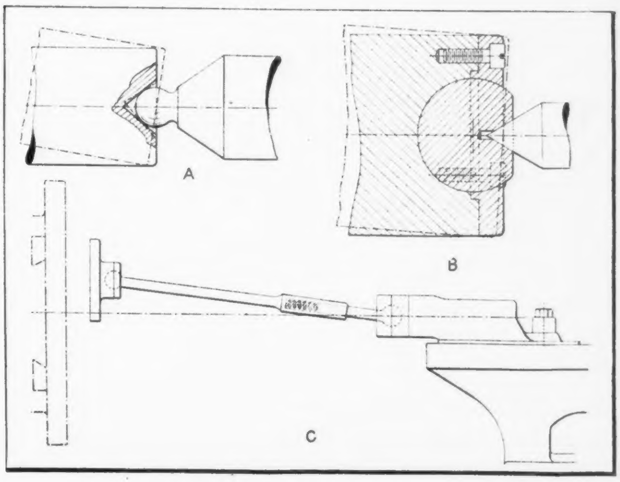


Fig. 6. (A) Ball-pointed Center for Angular Positions of Work; (B) Ball and Socket Bar; (C) Ball Center and Spring Plunger Device used with Oval Chucks

When the angular position of the work between centers is excessive, it cannot run properly on the usual points. This condition occurs when relieving a spiral thread milling cutter, which must be driven in a special manner and requires the tailstock to be set over a considerable distance. For such work, a pair of ball-pointed centers, shaped as shown at *A*, Fig. 6, is used.

When boring-bars are used for taper work, the moving over of the tailstock prevents the bar from running on the usual center. Consequently a ball center must be substituted, or, in some instances, a ball insert is placed in the end of the bar and secured with a retainer plate, as shown at *B*. Another plan is to use a hollow center, interposing a hardened steel ball between its cup and the countersink in the bar. For certain spinning lathe operations, a ball center device, such as shown at *C*, is used to press the work against the oval chuck, in order to allow free rotation. The rod and pad standing out from the footstock are nominally self-centering when at rest, but will float readily when in use.

The most common forms of hollow centers are shown at *G*, Fig. 7. Other styles differ chiefly in the shape of the recess. Large hollow centers are often used as drilling pads for ball-shaped work.

Pipe Centers

Instead of using a center like the one at *C*, Fig. 2, an enlarged head such as shown at *C*, Fig. 7, may be employed. This head or center is simply placed over the regular center. Another method commonly employed is to provide two or three different sizes of interchangeable heads for one shank, thus accommodating a large range of sizes. These heads are made a running fit on the shank. When the work is likely to be uneven, a better bearing may be insured by relieving the cone at three places so that contact will be made on only three ribs. A head of triangular shape, as shown at *F*, Fig. 7, is lighter in weight and will serve the purpose as well as the ribbed head in many cases. The larger heads should be cast hollow with strengthening ribs. Pipe centers cannot always be conveniently applied, and in some cases a fixed plug or spider located in the work and run on the regular centers is the most satisfactory method. A chuck may also be used, its jaws being expanded into the hole, while a centered plug is screwed in the hub, to receive a plain center.

Pipe centers can often be used to advantage as a means for locating a piece of work by its bore while it is being clamped or chucked. A like function is often performed in the boring and turning mill, using a center such as shown at *E*. This type of center may be made plain or with three ribs.

Loose Hollow Centers

The centering of work such as large castings, forgings, or pipes, from the outside, may be accomplished with centers of the type shown at *H*, which has a hardened steel plate insert that takes the thrust of the regular center.

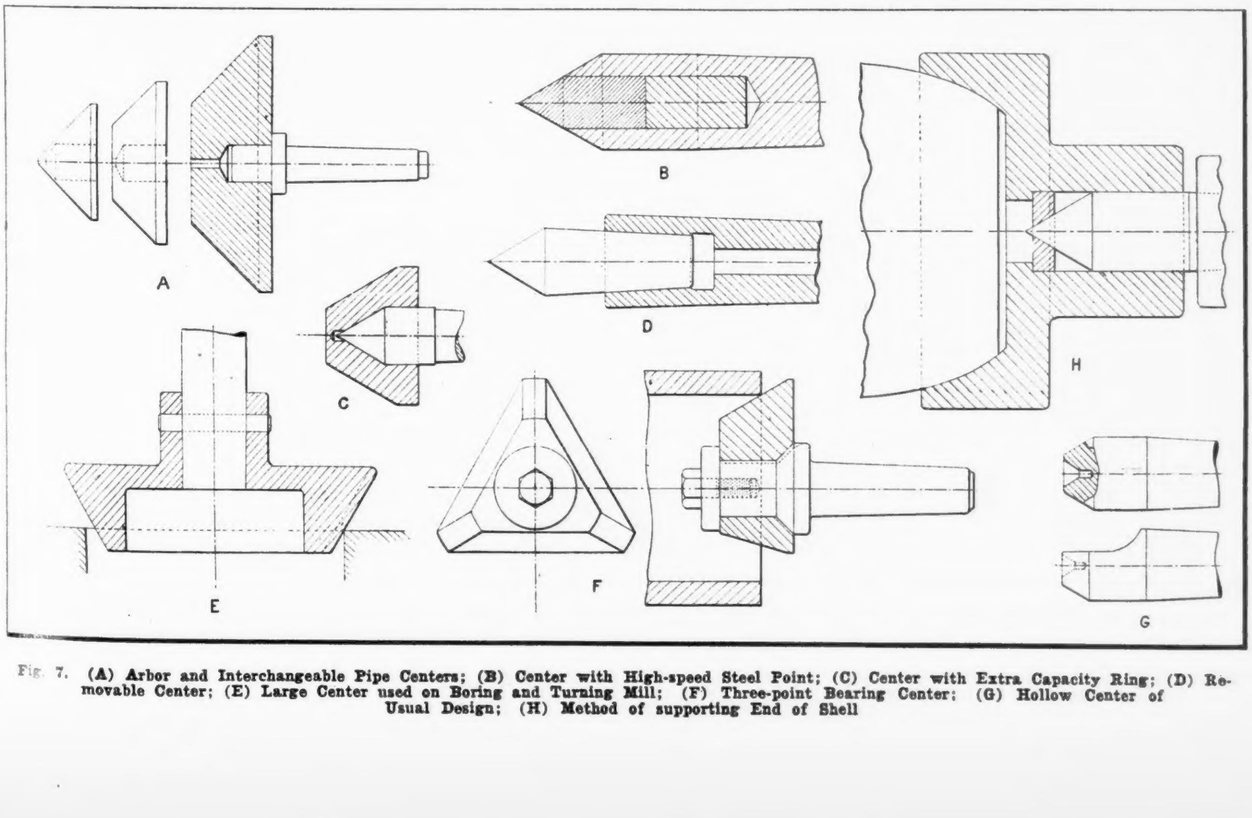


Fig. 7. (A) Arbor and Interchangeable Pipe Centers; (B) Center with High-speed Steel Point; (C) Center with Extra Capacity Ring; (D) Removable Center; (E) Large Center used on Boring and Turning Mill; (F) Three-point Bearing Center; (G) Hollow Center of Usual Design; (H) Method of supporting End of Shell

High-speed Centers

The higher speeds and feeds now prevalent have led to the extensive employment of high-speed steel centers as a means of overcoming the rapid wearing and burning of centers. To reduce the cost, only the end of the center is made of high-speed steel. Such ends are electrically welded or fitted to a shank. The center shown at *B* is of chrome-nickel steel, and the high-speed point is first welded to a machine-steel extension to give a good deep seat in the shank, which is bored slightly tapering. The insert is ground to match this taper and is forced in while the shank is hot and the assembly plunged into water. This method produces an exceptionally tight fit. At *D* is shown a removable center insert which can be driven out from the rear, thus enabling one shank to hold various points in succession.

* * *

PIERCING, CUTTING AND BENDING DIE

By JOHN STRAMA

The progressive piercing, cutting, and bending die shown in Figs. 1 and 2 was made for producing the steel clip shown at *W*, Fig. 2. The material used for this clip is carbon steel ribbon stock, 5/8 inch wide by 0.024 inch thick, having a carbon content of 0.40 per cent. The cross-sectional view in Fig. 1 shows the assembled punch and die and the work as it appears at the completion of the downward stroke of the press ram. The punch or upper member of the die is provided with a long round piercing punch *A*, a double piercing punch *B*, the first bending punch *C*, parting tool *D*, and the final bending punch, consisting of the inner member *E*, the outer member *R*, and the spring *S*.

The die or lower member consists of the piercing die *F*; the bending die *G*, which is provided with the ejector *H* backed up by a coil spring; and the parting and bending die *I*, with the gage pins *J* and springs *K*. All these parts are, of course, made from tool steel and properly hardened. The punch members are located in the holder *L*, and the die members in the shoe *M*.

The order in which the operations are performed is as follows: The material is first fed forward under the stripper plate *N*, Fig. 2, against the starting pin *P*. At the first stroke of the press, the punches *A* and *B*, Fig. 1, pierce the round hole and the two slots, after which the stock is advanced to the gage pins *J*. At the next down stroke of the ram, the long punch *A* pierces the work first, and thus holds the strip from moving in either direction while the punch *B* pierces the stock, and the cutting tool *D* cuts it off to the proper length, rounding the corners as shown in the view at *W*, Fig. 2. As the press ram continues to descend, the tool *C*, Fig. 1, bends the end of the strip to a vertical position, as indicated in view *X*, Fig. 2.

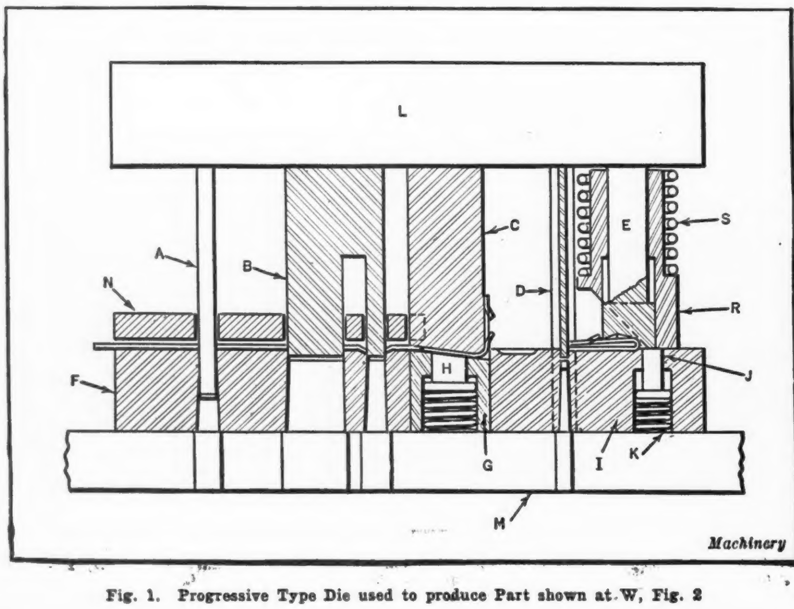


Fig. 1. Progressive Type Die used to produce Part shown at W, Fig. 2

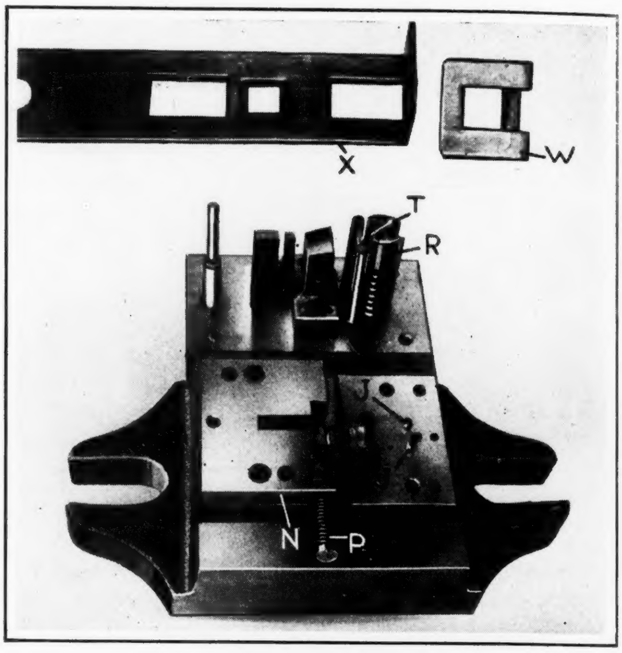


Fig. 2. Punch and Die and Enlarged View of Work

At the next advance of the strip, the first bend is fed to the gage pins *J*, Fig. 1, and as the ram descends again, the final bend is made by the punch consisting of the three members, *E*, *R*, and *S*. This punch works on the double-acting order. The outer member *R*, which is under the tension of spring *S*, bends the strip from the 90-degree position to an angle of 45 degrees under the spring tension. One of the 45-degree surfaces on member *R* which accomplishes this bending operation can be clearly seen at *T*, Fig. 2. The gage pins *J*, Fig. 1, are spring-actuated, and when the punch descends, it forces these pins downward until the punch strikes the surface of the die, which causes the member *R* to dwell in that position during the remainder of the down stroke while the central member *E*, or final forming punch, completes the bending operation. The finished clip is separated from the strip by the parting tool *D*, after which it is ejected by air pressure. After the series of operations described has been performed, a finished piece is produced at each stroke of the press.

* * *

THE MACHINE TOOL MARKET IN INDIA

According to recent reports, the imports of metal-working machinery into India during the last fiscal year amounted to over $1,000,000, machine tools accounting for 70 per cent of this total. Of this amount, the United Kingdom supplied 77 per cent and the United States 15 per cent. The British trade commissioner making this report states that, while American machine tools are well thought of in India, the leading British makers are so strongly represented in the Indian market that they obtain by far the largest proportion of the business offered in this field.

The British machine tool builders handle the British market on a cooperative plan, and it is stated that they are contemplating a substantial increase in their organization in India, where they now maintain three sales engineers in addition to a general sales manager. It is likely that they will add three more engineers who will be available as service men. On account of the aggressiveness of the British machine tool builders in the Indian market, it is believed that the United States can obtain a proportionate share of this business only if American machine tool builders adopt sales methods similar to those used by our British competitors.

LATHE ARBOR FOR HOLDING GEAR BLANKS

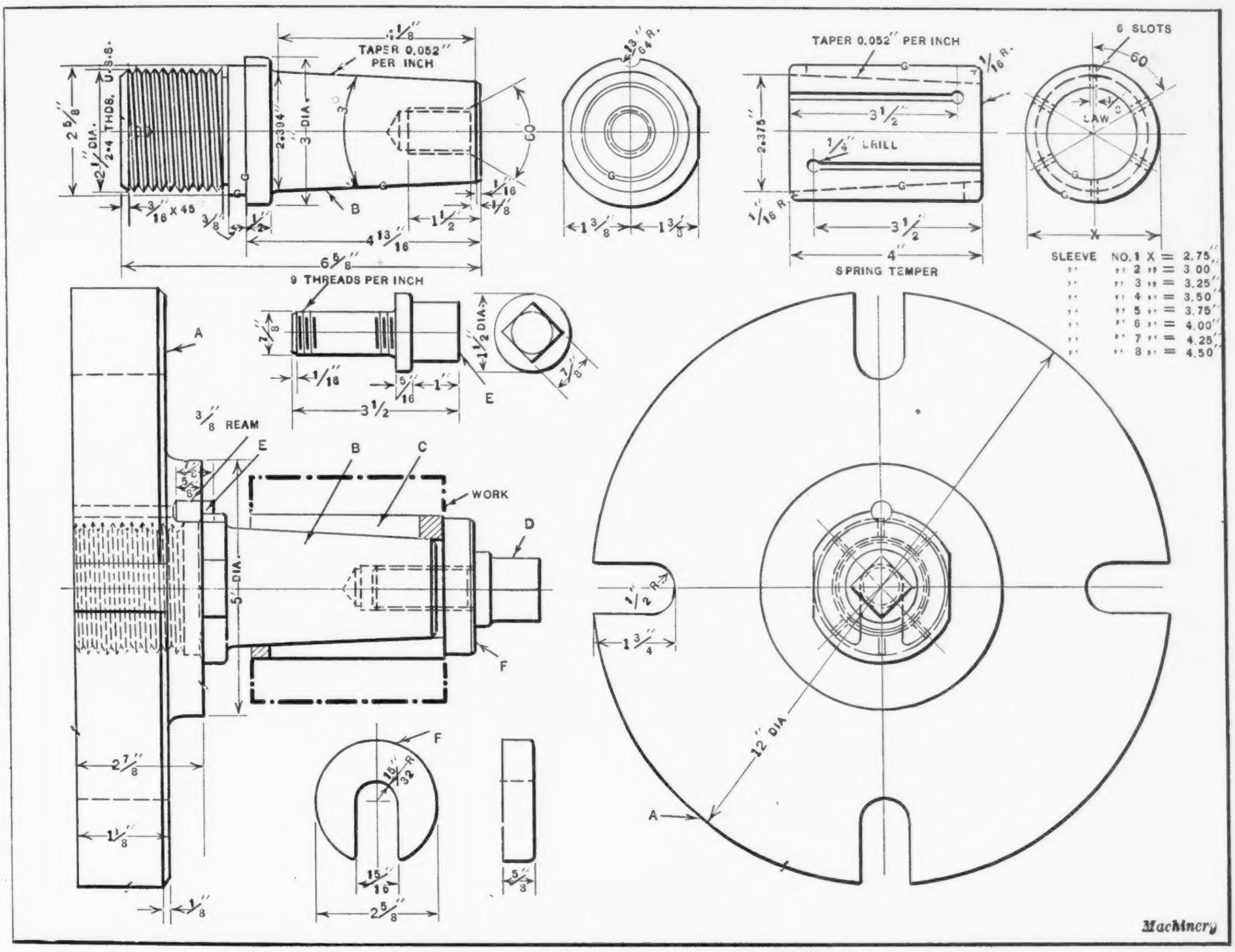
By ROBERT MAWSON

A large number of gears and pinions of different sizes, with different shaft-hole diameters, are machined in the shop where the writer is employed. The shop is rather unusual in that all the work is for repairs on the equipment of its own plant. Thus the general run of work is similar to that of a large jobbing shop. The volume of work is so large, however, that much of it can be done profitably on a production basis. In order further to advance the latter practice, a special fixture or arbor was made for use in machining gear and pinion blanks. This arbor, which is shown in the accompanying illustration, was designed primarily for machining gear blanks from solid steel forgings. The first operation on a blank is to drill and bore the center hole to fit the shaft on which the finished gear or pinion is to be assembled.

The bored blanks must be turned and faced to the proper dimensions, and it is obvious that if they are mounted on solid arbors in the usual manner for the machining operations, a large assortment of arbors would be required. It would, of course, be possible to use an expansion arbor to hold the blanks, but this is rather expensive and some designs are not rigid enough for heavy production work. Consequently, the special arbor shown in the illustration was devised; this is rigid enough for heavy turning and facing operations, and can be used to hold a wide range of sizes.

The arbor is made with a cast-iron faceplate *A*, which is turned on the outside and fastened to the standard faceplate of the lathe by means of four studs. The outside of the arbor faceplate is machined so that the operator can true it up by means of an indicator, before fastening it in position. The arbor *B* is made of machine steel, and is hardened and ground to the taper indicated in the illustration. This arbor is screwed into a threaded hole in the center of the faceplate *A*, the thread being made a tight fit. After the arbor has been screwed into position, a dowel-pin *E* is driven into place to prevent it from moving when the fixture is in use. A hole drilled through the rear part of the faceplate permits the dowel-pin to be driven out if, for any reason, it should be desirable to remove the arbor from the fixture. The dowel-pin groove in the arbor is, of course, machined before hardening this member.

In order to cover as many sizes of bored blanks as possible, a number of spring sleeves *C* were made, as shown in the detailed views in the upper right-hand corner of the illustration. These sleeves are made of tool steel and slotted, as indicated. They are hardened to give them a spring temper, and are afterward ground on the outside. The taper holes are also ground to fit the arbor *B*. These sleeves are made with different outside diameters *X*, as tabulated below the detailed view of the sleeve or bushing. To use the fixture after it has been aligned and fastened to the lathe faceplate as described, a spring sleeve which fits the bore in the blank to be machined is placed on the arbor *B*. The gear blank is then placed on the sleeve, and by tightening the screw against the C-washer *F*, which, in turn, presses against the sleeve *C*, the latter part is forced to expand in the bored hole of the blank until the blank is held securely in place on the arbor.



Lathe Arbor for holding Gear Blanks

The holding power of this arbor is sufficient to permit heavy cuts and feeds to be employed. If desired, spring bushings of various outside diameters can be made to fit the arbor. An arbor of the kind described should be found very useful in most machine shops, not only for job work, but also for production work, as it can also be used for holding other work than gear blanks. It might be mentioned that the arbor described is in such constant use that it is not removed from the lathe on which it is mounted, although the work of removal or resetting can be easily done.

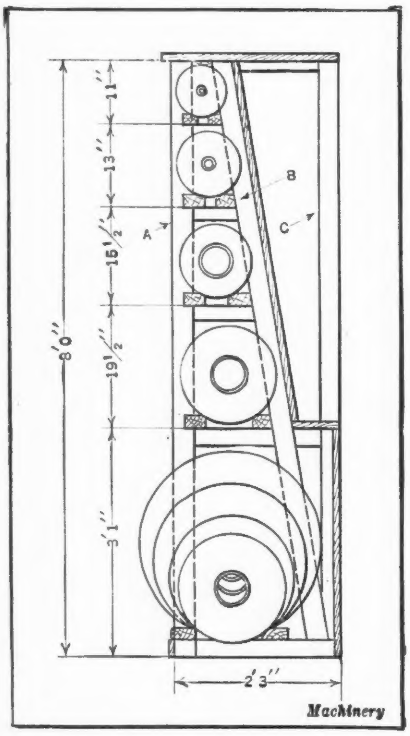
STORAGE AND HANDLING OF GRINDING WHEELS

From time to time cases of wheel breakage arise where the cause may be traced directly to improper storage methods. The question of storage and handling so directly affects the operating safety that it should be carefully considered and more than the usual attention given to it.

Dropping or careless stacking of wheels may not leave any visible mark, but may result in serious trouble when the wheel is mounted in a machine and brought up to speed. The following information on the handling and storage of grinding wheels, by R. E. Taylor of the Sales Engineering Department of the Norton Co., Worcester, Mass., appeared in a recent number of *Grits and Grinds*. This article should be of practical value to those who use or handle grinding wheels.

Unpacking Wheels

When grinding wheels are shipped by the manufacturer, they are packed in a way that should safeguard the package against the roughest sort of treatment in transit. When unpacking wheels, a reasonable amount of care should be used. If the unusual has happened and there is a breakage, it should be reported at once. After unpacking the wheels and before placing them in stock, they should be examined to see that grain, grade, and other specifications correspond with the original order.



Storage Rack for Grinding Wheels

Tapping Test

Before the wheels are put into storage, they should be put through the tapping test. To have this test effective, the wheels must be free from sawdust and thoroughly dry. Being sure that these two conditions are met, the wheel should be held out of contact with the floor by means of a rod placed through the hole. The wheel should then be tapped with a wooden mallet or a stick of hard wood. A sound wheel will ring clear. If the wheel does not ring clear, it should be rejected until a more thorough examination can be made.

Storage Racks

Wheels should be stored in suitable racks designed to guard them from injury. The practice of stacking wheels on their sides on the floor is conducive to strains which may cause cracks and breaks when the wheels are put in operation. This condition is aggravated if the floor is not perfectly flat.

The racks should be of such design as to eliminate all danger of the wheels being dislodged by sudden jars. This can be accomplished by making the shelves of parallel beams placed 3 or 4 inches apart. The accompany illustration shows a cross-section end view of a model wheel rack. The spacing between the upright members *A*, *B*, and *C*, should be about 28 inches. A satisfactory method is to arrange the wheels in vertical racks according to the following plan: Large to small, thick to thin, coarse to fine, and soft to hard. By following this or a similar arrangement, it is an easy matter to locate any specific wheel out of a large stock.

Storing Shellac Wheels

Shellac wheels, 1/4 inch thick and thinner, if laid flat, should be placed on a shelf with a smooth, flat surface to prevent warpage, and with a block of slate under each pile.

Stacking "Shape Wheels"

Saucer, cup, or even straight wheels which are not over 6 inches in diameter and are made by either the vitrified or silicate process may be stored either on their edge or stacked flat. Wheels with a thin edge should be stacked on their side. Cup-wheels over 6 inches in diameter and all cylinder wheels should also be piled flat. Taper cup-wheels should be stacked carefully, with the back side up. All rubber wheels 1/4 inch and thicker should be stacked on their edges or preferably hung on pegs. Wheels 2 inches or less in diameter are best cared for by placing them in boxes and drawers with the grain and grade plainly labeled on the outside.

Handling Wheels

The greatest amount of care should be exercised at all times during the transportation of abrasive wheels into and out of storage. Wheels between 20 and 28 inches in diameter, of grain 60 and finer, should be moved on their sides, on transfer platforms. In the event that more than one wheel is carried at a time, boards should be placed between them. Wheels larger than 28 inches should be carried on trucks that will hold them in a vertical position. This practice is usually more convenient and minimizes breakage.

Abrasive wheels should not be subjected to radical temperature changes immediately before being put into use on the grinding machines. The wheels should be at least up to room temperature before grinding is started. Should the wheels be at a low temperature, the heat generated on the face of the wheel by grinding will cause an uneven expansion which might be great enough to cause breakage.

The greatest of care should be exercised in the handling of abrasive wheels. Proper supervision of the storage and handling will, in most cases, show a reduction in wheel breakage, give better wheel efficiency, and on the whole, a lower wheel cost.

* * *

EXCESS PLANT CAPACITY IN THE INDUSTRIES

In a recent statement issued by John F. Sherman, president of the Sherman Corporation, 2 Rector St., New York City, it is stated that factories and mills in every line of industry are heavily over-capacitated, according to surveys that have recently been made. In many fields, thousands of employes, instead of working 300 days a year, are working 200, or only 150 days. The companies, in turn, are carrying the burden of unused floor space and of machinery that is only partially employed. At the same time, new companies are being formed to make new products, many of which could be manufactured in plants already existing and suffering from over-capacity. This would created more steady employment, reduce manufacturing costs, and prevent waste of capital.

To quote Mr. Sherman: "There is little if any economic justification for many new companies. They waste millions in capital, frequently benefiting only that small portion of society which profits by financial promotion. They originate in the desire of some individual to make a fortune out of a new alarm clock, a reversible rubber heel, an automatic window opener, or some other product which we could very well get along without. Many of these ideas and projects can be used to absorb our present industrial over-capacitation."

The Sherman Corporation has organized a new division with the view of bringing together new products and plants having facilities to make them. This division will also analyze market limitations and possibilities for both established and new products.

Notes and Comment on Engineering Topics

The electrification of existing steam-driven rolling mills continues at a high rate, and several new mills with motor drive were contracted for during the past year. The increasing appreciation of the advantages of adjustable-speed drives for certain types of mills is evidenced by the large number of direct-current machines for which orders have been placed.

A huge power development has been planned by the Tennessee Valley Power Survey. Should the plans materialize, approximately 100 dams built across rivers in this part of the country would make it possible to generate 4,000,000 horsepower. Applications for the building of the first twenty-four dams to generate 1,441,000 horsepower have already been made by four companies.

A serious problem has arisen during recent years because of the pollution of rivers and harbors by waste oil from oil-burning vessels. The Bureau of Standards is assisting in the solution of this problem by gathering data on the actual performance of various types of oil-water separators, and it is now believed that gravity separators can be installed which will remove from 95 to 99 per cent of the fuel oil present in ballast water.

The total capacity of the electrical generating plants of New York City is, in round numbers, 2,800,000 horsepower, and this does not include a million horsepower plant now under construction. The entire capacity of both the Canadian and American plants at Niagara Falls is less than half the present capacity of the plants in Greater New York. The present capacity at Muscle Shoals is less than that of only two of the large electrical generators in the Waterside plants of New York.

The British Engineering Standards Association has drawn up specifications for standardized ebonite panels for radio receiving sets. These specifications—No. 234, 1925—rigidly specify the composition of standard ebonite that possesses adequate mechanical and electrical qualities. A recommended list of sizes and thicknesses of panels is included. Copies of the specifications may be obtained from the British Engineering Standards Association, Publications Department, 28 Victoria St., London, S. W. 1, England. The price is 1s. 2d.

A heavier-than-air machine known as the "autogiro," which has been developed by a Spanish engineer, Juan de la Cierva, embodies some of the principles of the airplane and some of the helicopter. This machine has a fuselage, propeller, and control devices essentially like those of an airplane, but instead of the planes it has a four-bladed device capable of free rotation under the action of air coming from the propeller. In a recent test conducted in England, it was found that, while the auto-giro cannot hover over one spot, it can both rise and descend in a nearly vertical line.

Manufacture of iceless refrigeration installations for general use has reached an importance which makes it one of the largest of the newer consumers of copper, according to a survey by the Copper and Brass Research Association. It is estimated that the iceless refrigeration units that will be manufactured in 1926 will require almost 30,000,000 pounds of copper. Motor windings and parts, switches, wiring, etc., of the electric and mechanical equipment used are of copper. Compressor parts, tubing, tanks, etc., are also of copper. In ice-cream boxes large amounts of sheet copper are used for tanks and tank covers.

An interesting use of an automobile bus is being made by the Prospect Boiler Works, New Brunswick, N. J. This company has installed a General Electric arc welder and air compressor in a bus for field welding. The arc welder and air compressor are gas-engine-driven, so that work can be done in any location. Equipment of this kind is generally mounted on motor trucks, but the use of an enclosed motor bus is novel. It is, however, a real advantage, as the welding equipment is protected from the elements by being totally enclosed. The outfit also proves to be a valuable advertisement, resulting in increased business for the owner.

In carrying on the enormous tabulating and sorting of data collected by the Census Bureau at Washington, not less than 2042 punching, calculating, adding, sorting, numbering, and tabulating machines are employed. The large units of this equipment—the electric sorting and tabulating machines—were invented, developed, and constructed in the mechanical laboratory of the bureau to meet the peculiar requirements of the statistical work of the census. The force working in the Census Bureau on June 30, 1925, comprised over 700 regularly employed men and women, in addition to over 1000 temporary employes engaged in the work of the census of agriculture.

It is pointed out by E. E. King, professor of railway civil engineering at the University of Illinois, that fewer accidents actually occur in railway train service than in homes. Much of the safety in operation of railways is brought about by the use of automatic block signaling devices controlled by the movements of the trains themselves. The cost of automatic block signal equipment runs over $2500 per mile. There are about 40,000 miles of track in the United States so equipped, the total cost of which, therefore, probably runs in excess of $100,000,000. This is for automatic block signaling alone and does not include the 60,000 miles of track operated under other forms of block signal control; nor does it include signaling apparatus installed for the protection of railway and highway crossings and for the operation of large railway terminals.

Stainless steel is being more and more generally employed in industry. Its first uses naturally were for cutlery, but there are also many uses in general engineering work, as, for example, for turbine blading, pump rods, superheated steam castings, and similar purposes where steel is subjected to corrosion. One very interesting application is the use of stainless steel for sluice gate castings. A set of these was put in operation three years ago, and when examined recently, it was found that they were practically unaffected by the corroding influences to which they had been subjected. It has been pointed out, in this connection, that stainless steel cannot be expected to be used for general purposes, in spite of its wonderful qualities, because the supply of chromium—one of its most important ingredients—is limited, and there would not be enough chromium to permit of all or even a majority of the steel made in the world to be of the stainless type. Furthermore, the expense of such steel for purposes where it is not very important that it be highly rust-resisting, would be prohibitive.

GROUND STONE

What is known as "ground stone" is used by some small tool manufacturers for lapping plug gages, ring gages, etc., and this material is also used, to some extent, in connection with watch manufacture, for fine lapping operations. "Hindostan powder" is produced from a very fine sandstone which is quarried in Indiana. Another ground stone known as "Turkey powder" is composed of pulverized Turkish oilstones, which are imported. An expensive grade of ground stone is known as "Arkansas powder;" it is pulverized Arkansas rock and is quarried in Arkansas. The Turkey powder and Arkansas powder have been used quite extensively in connection with watch manufacture.

MINOFOR METAL

Minofor metal is a tin-antimony-copper alloy containing a large percentage of zinc. It belongs to the Britannia metal class, and contains, on an average, 68.5 per cent of tin, 18.2 per cent of antimony, 3.3 per cent of copper, and 10 per cent of zinc.

HYDROMETER

The hydrometer may be defined as an instrument for determining the density or specific gravity of a liquid. Special hydrometers are also used for other purposes. Classified in the broadest sense, there are two types of hydrometers; namely, hydrometers proper and hydrometers that are combined with thermometers, generally known as "thermohydrometers." Hydrometers proper may be divided into four specific classes: (1) Density hydrometers, which indicate the density of a liquid on a given scale. (2) Specific-gravity hydrometers, which indicate the specific gravity or relative density of a liquid as compared with water. (3) Per cent hydrometers, which indicate the percentage of a substance in a mixture or solution with water. (4) Arbitrary-scale hydrometers, which indicate the concentration or strength of a liquid on an arbitrarily defined scale. This latter class includes the well-known Baumé type of hydrometer. The hydrometer consists of a glass tube having a weight at one end, so that it will float in a vertical position in the liquid the density of which is to be measured. The glass tube is provided with graduations on which the density is read off. When reading a hydrometer, the liquid is placed in a glass jar or cylinder, and the hydrometer carefully immersed in it to a point slightly below that to which it would sink by itself, and is then allowed to float freely. The reading should not be taken until the liquid and the hydrometer are fully at rest. The reading should be taken with the eye placed exactly in the plane of the surface of the liquid.

REACTANCE COILS

Current-limiting reactance coils utilize their counter-electromotive force of self-induction to reduce the flow of current in an alternating-current circuit. With the present tendency toward very large generating stations and units, and the concentration of large amounts of power at one place, it is evident that short circuits may give rise to very destructive effects. It therefore becomes imperative that the flow of energy is such cases be limited to a safe value, and the damaged part isolated as quickly as possible, so that the trouble will not spread to other parts of the system. The current rush is reduced by providing a sufficient amount of reactance in the circuits. In some cases, the inherent reactance of the apparatus may be increased to a value sufficiently high to limit the current to the desired value, while in other cases, it may be necessary to resort to external reactance coils.

MOLDING MACHINES

Molding machines are extensively used in modern foundries, especially where duplicate castings are required in large numbers. The function of these machines varies with different types. Some molding machines are designed for ramming or packing the sand in the molds, whereas other types are intended primarily for turning or rolling over the flask or mold, and withdrawing the pattern after ramming. Molding machines were designed originally for withdrawing the pattern from the sand by a steady mechanical action, in order to avoid breaking away parts of the mold, which often occurs when a pattern is removed by hand. Withdrawing the pattern is still the most important function of certain types of molding machines, but many of the designs now in use are also arranged for ramming or packing the sand by mechanical means. There are three general classes of molding machines: (1) Those that withdraw the pattern after the mold has been rammed by hand; (2) those that ram or pack the sand into the mold, but are not designed to withdraw the pattern; and (3) those that serve both to ram or pack the sand and withdraw the pattern from the mold. These three classes include many designs and types that differ in regard to the source of power for operating them and the mechanical action either for packing the sand or for withdrawing the pattern. For instance, some machines, especially those used for small work, are manually operated, whereas others are actuated either partially or entirely by power. There are several methods of packing or ramming sand around patterns in molds. The terms applied to the different methods indicate the general nature of the ramming operation; thus, there is the "jarring" or "jolting" method, the "squeezing" or "pressing" method, the "gravity" method, and the "roller" method.

HEAT UNITS

The unit of heat measurement used in English-speaking countries is the British thermal unit (B.T.U.), which is the quantity of heat required to raise the temperature of one pound of pure water one degree F. The French thermal unit, or kilogram-calorie, is the quantity of heat required to raise the temperature of one kilogram of pure water one degree C. One kilogram-calorie equals 3.968 British thermal units, and it also equals 1000 gram-calories. The number of foot-pounds of mechanical energy equivalent to one British thermal unit is called the "mechanical equivalent of heat," and equals 778 foot-pounds. One foot-pound equals 0.001285 heat unit.

SLIDE REST

The real foundation of modern machine tools was laid about 1794 by Maudslay who developed the first slide-rest to receive general practical application. Apparently Maudslay was not acquainted with the French slide-rests that had been in use previous to 1772, and, on account of the development that has followed the design of slide-rest made by him, the credit for the development of the slide-rest is generally given to Henry Maudslay, of London. Up to about the time of Maudslay's design of slide-rest, the best lathes in existence were quite similar to the present patternmakers' speed lathe, there being a light headstock and tailstock, and an adjustable rest for a hand tool which was used for metal as well as for wood. The ways or shears, however, were made of wood. About 1800, Maudslay provided his lathe with lead-screw and change-gears, in addition to a slide-rest, and from then onward the development of the modern machine tool has been continuous and rapid.

LATTEN

Latten is an alloy of copper and zinc, and belongs, therefore, to the class of alloys generally known as brasses. Latten is made in thin sheets and used especially for monumental brasses and figures. It is made in three commercial forms; black latten, which is rolled but unpolished; shaven latten, which is unpolished, but of extreme thinness; and rolled latten, which may be similar to either black or shaven latten in thickness, but which has both sides polished.

AIR CHAMBER ON PUMP

Air chambers are used in connection with pump cylinders to reduce shock or "water-hammer," to permit higher speeds, and to give a more uniform discharge of water. The air chamber is attached near the discharge or outlet end. When the discharge occurs, the air in the chamber is compressed by the water, or other liquid, which is forced up into it. The air chamber thus acts as a reservoir and forms a cushion. When the pump plunger is passing the end of its stroke, and the discharge greatly decreases or diminishes entirely, the compressed air in the chamber tends to keep the water moving through the discharge pipe, thus relieving the pump shocks by providing an elastic cushion and equalizing the rate of discharge so that the flow is more uniform. Air chambers are particularly essential on pumps of the crank-driven type (especially if single-acting), because the speed of the plunger varies decidedly throughout the stroke. Many duplex direct-acting pumps do not have air chambers. The volume of the air chamber for ordinary boiler-feed and service pumps should be from two to three times the piston displacement for a single-cylinder pump, and from one to two times the displacement for a duplex type. If the piston speed is unusually high, as in the case of fire pumps, the air chamber should have a volume equal to about six times the displacement. Air chambers are sometimes applied to suction pipes, especially if the pipe is long, and the resistance to the flow of water is considerable. The pressure in the suction air chamber is always less than the atmospheric pressure when the pump is in operation, and for that reason it is sometimes called a "vacuum chamber." When the pump is running, the suction air chamber provides a cushion that gradually stops the movement of the column of water at the end of a stroke and assists in starting the water again on the next stroke.

MARBLE

Any limestone which is sufficiently compact to admit of being polished is known as "marble." Pure marble is white, but the presence of iron oxides or other impurities changes the color. Marble is of importance in electrical engineering, because of its insulating qualities, and is the material principally used for switchboard work, in which case it should contain no metallic veins, as these reduce its insulating qualities. The dielectric strength of marble is estimated at 6500 volts per millimeter (0.0394 inch). There is some difficulty in drilling or otherwise shaping marble. In drilling marble, the operation is greatly facilitated by grinding or filing a narrow slot in the point of the drill. This slot should be about 1/8 to 1/4 deep, according to the size of the drill, and should form an angle of a little less than 90 degrees with the cutting edges. Marble is a difficult material to turn. When turning is necessary, it should be cut with a tool such as is used for brass, but at a speed suitable for cast iron. It must be handled very carefully in order to prevent flaws in the surface.

COPPER WIRE STRENGTH

The strength of copper wire can be greatly increased by proper methods in the drawing operation. It has been found that the strength can be increased nearly 100 per cent by omitting the annealing process during the latter part of the drawing, at the same time making the steps of gradations between the successive dies smaller. In this manner, copper wire will obtain a very hard surface, and is known as "hard drawn." The increase in strength is greater for smaller diameters, as the treatment will affect a proportionately larger part of the cross-section. A No. 8 copper wire (0.165 inch in diameter) can be given a strength of 62,000 pounds per square inch of cross-section, while a No. 12 wire (0.104 inch in diameter) may obtain a strength of 64,500 pounds per square inch. As ordinary commercial copper wire has a tensile strength of only 32,000 pounds per square inch, the effect of correct methods in drawing is very marked. The modulus of elasticity is increased by these methods from 12,000,000 to 19,000,000 pounds, but the elongation is reduced from 35 to 1.25 per cent. It should be noted that this change is effected entirely by manipulation in the drawing, and not by the addition of any alloying metal.

HELIUM

Helium is one of the lightest of the gases, although not so light as hydrogen, its specific gravity, compared with air as a unit, being 0.138. Helium is present in small quantities in the atmosphere, and also in many minerals. It is contained almost universally in the gases in the water of thermal springs. It does not enter into a chemical combination with any other chemical element, but is always mechanically mixed or contained in the substance in which it is found. Helium becomes liquid at a temperature of only a few degrees above the absolute zero, and becomes solid at a temperature only two degrees below that at which it liquefies, these temperatures being around —267 degrees C. (—449 degrees F.).

RESISTOR

A resistor limits the current in an electric circuit by transforming a portion of the electrical energy into heat, which may be stored temporarily in the resistor, but is ultimately dissipated to the surrounding medium, which is usually the atmosphere. It is the basis of nearly all controlling devices and is made in the following different types: The tube type, which consists of a tube of fireproof insulating material on which the resistance wire is wound; the bar type, which consists of a flattened tube or an iron bar insulated with a fireproof material on which the resistance wire is wound; the ventilated wire type, which consists of an insulated support on which the resistance wire is wound; the edgewise type, which consists of a conductor of narrow ribbon wound edgewise on a suitable mandrel, after which it is dipped in a thin mixture of fireclay or other fireproof insulating material; the plate type, which consists of a molded plate of insulating material in which the resistor wire is imbedded, the contact points projecting through the surface of the plate; the cast-iron grid type, which consists of a special grade of cast iron of suitable shape, so as to insure sufficient length and mechanical strength. The property of dissipating the absorbed energy by the transference of heat to the surrounding medium is known as the "radiating capacity," and the property of absorbing energy by storing it in the form of heat, as the "thermal capacity" of the resistor.

What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

INSTALLING MACHINES ON TRIAL

Referring to the editorial comment in March MACHINERY on the subject of installing machines on trial, it may be of interest to mention that our company has, on several occasions in the last few years, been requested to install Blanchard grinders on trial, in competition with other equipment. In each case we have refused to do this, but have offered to fully demonstrate our machines at our factory on the customer's work and in the presence of his representative. We are also willing to promise equal production and accuracy under proper working conditions in the customer's shop. In no case have we lost any business by taking this stand.

THE BLANCHARD MACHINE CO.,
Henry K. Spencer, Manager

SUPPLYING EXECUTIVES THAT MEET THE DEMAND

The supply of good executives will never meet the demand unless the present method of developing men to fill such positions is changed. Many young men, when they leave college, have a good idea of their ultimate goal, and of about how far along they should be when they are about thirty-five years of age. They have education, a good personality, plenty of courage, and are willing to work hard to reach their goal. The one big thing they lack is a plan.

No plan for the future is taught in school, nor is one available in books. The average young man seldom meets an older man capable of giving sound advice covering a period of eight to twelve years after graduation. This leaves many highly desirable young men free to drift, which is exactly what is happening today in thousands of cases.

W. W. Lawyer brings out a very interesting point about experience in his article in January MACHINERY. In my estimation, he describes the conditions perfectly. When a man makes an application for a position, it is the questions about experience that cause the most concern. Some employers want to know if he is a specialist in his particular business, and if he is not, he receives no encouragement. Other jobs are open only to men with a varied experience who can see problems in a broad light.

There are a great many positions that require a varied experience if the best results are to be had. Men in positions such as superintendents, production engineers, master mechanics, chief engineers, and sales managers should know a good deal about different phases of industry. The problem is: How is this training going to be acquired and how much experience in each kind of work is necessary for the different positions? The only men capable of describing a good plan or stating specifically the details of experience needed to fill these positions are the employers. It would be a fine contribution to industry if a number of successful men would write their opinions for publication in the technical journals. These would be read by thousands of men, and should set them thinking. After a careful self-analysis, the weak spots in their experience would be apparent and in many cases corrected. The young men with only a few years of experience would get a good idea when to change from one kind of job to another in order to secure a well rounded out training.

One of the hardest times in the life of an engineer is when he is trying to get a foothold in industry and does not feel sure that he is starting in the best way. Another discouraging time is when a man reaches about thirty-five, with a good experience, and feels it is time to rise in the world. He makes many attempts, but does not succeed, and the sad part of it is that he never is told why. Surely many men would be happier to know more about how to prepare for better positions. The employers would also be able more easily to find men with definite training to fill important positions.

LAWRENCE F. SWENSON

WHAT DETERMINES MACHINE TOOL PRICES?

The value of a machine tool—or of any machine used in the industries—does not depend upon the cost of building it, but wholly and entirely upon its productive capacity when placed in service. This is a self-evident fact. But the machine tool builder must consider his costs, for he cannot long stay in business if he does not; and all the factors entering into the cost of building a machine must necessarily be considered in fixing the selling price of a machine tool.

It is a curious fact—but nevertheless a fact from which the industry cannot escape—that while it costs more to build machine tools in quiet times than in periods of good business, machine tool prices are always lower when the costs are high, because competition does not permit of a price advance proportionate to the increased costs. As soon as a reasonable volume of business returns, prices go back to levels that make it possible for the manufacturer to obtain a reasonable return on the capital invested and a fair compensation for the ingenuity and effort that has been put into modern machine tool design. At such times the machine tool builder must make a sufficient profit to enable him to remain in business and to tide over the lean years that this industry always experiences. Without it, it would be impossible to maintain the machine tool industry on an efficient and progressive basis, which is absolutely necessary for the continuance of the mechanical development in other industries.

MANUFACTURER

OVERWORKED FOREMEN

The timely article entitled "Overworked Foremen" on page 470 of February MACHINERY is full of interest to me. Thomas Carlyle once remarked, "The world is full of willing people—those who are willing to work, and those who are willing to let them." The managements of factories should not allow their foremen to do detail work that can be done equally well by mechanics, semi-skilled workers, or clerks. The writer has known foremen who prepared estimates for work, made sketches, filled out requisition blanks for all material, did clerical work, set up the machine for every new job, and who went out of their way to do many odd jobs, and yet their departments were not efficient.

A foreman should not neglect any of his important duties in attempting to handle detail work. His ability is needed to solve the important problems. It is the foreman's duty to increase production whenever possible and reduce the cost of manufacture by introducing improved methods and equipment. He must take advantage of every opportunity to eliminate unnecessary work and to introduce improvements in tool equipment and time-saving methods. He must also do everything possible to conserve material. The larger the production, the greater are the chances for improvement.

It is obvious that the requirements of a machine shop foreman are constantly becoming more exacting. Bigger men will be required in the future to fill these positions—men with greater foresight and organizing ability. Such men must not be loaded down with detail work.

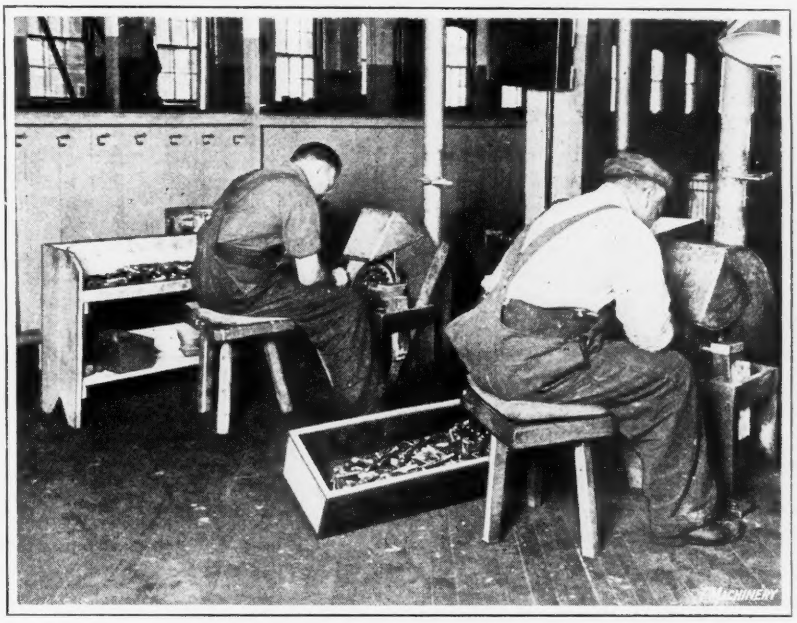
E. A.

POLISHING POCKET-KNIFE PARTS

In the polishing of pocket-knife blades, springs, scales, etc., the small size of the surfaces to be polished and the sharp corners that must be maintained require that wheels of different sizes and densities be employed than those used for larger kinds of cutlery. If compress wheels are used, the back of the springs should be finished with a split leather wheel of extra hard density having a 1-inch cushion and a flat face, 3 inches wide. The inside of the springs, which are curved to suit the shape of the blades when the knife is closed, should be polished on either a leather or a canvas wheel of hard density having a 2-inch cushion. These wheels are often formed to fit the curvature of the inside of the springs, and the face may be anywhere from 1 to 2 inches wide.

The so-called "bolsters" at the rear end of the blade are polished on medium density canvas wheels having a cushion 2 inches deep and a flat face 1 1/2 inches wide. The scales, or thin brass shims placed on both sides of the springs, require a split leather wheel of extra hard density, these wheels having a 2-inch cushion and a width of face from 2 to 3 inches.

The glazing of pocket-knife blades may be done by hand, using either a regular polishing lathe or a double-header machine. Canvas wheels should be used for this work, and if the polishing is done by hand they should be of hard density; when a double-header polishing machine is used, the wheels should be of a soft or medium density. They should be 24 inches in diameter by 1 inch width of face, with a 2-inch cushion, if used on a double-header, while they are generally about 16 or 18 inches in diameter if used on a polishing lathe.



Part of Polishing Room in a Pocket-knife Plant

For the final finishing or fine glazing of these blades, compress walrus wheels of soft density are suitable. These wheels may have a cushion of 2 or 3 inches depth, and should be 1 inch wide on the face, their diameter depending upon the type of machine upon which the work is performed.

Variation in Pocket-knife Polishing Practice

The methods outlined are not always employed in the polishing and glazing of pocket-knives, as there are considerable variations in practice. The methods employed at the plant of one well-known cutlery concern, for example, in polishing pocket-knife blades and springs differ to some extent from the practice outlined. Such differences in polishing practice are quite common, each method having been designed to produce the quality of work required by the product made by each particular plant. At the plant referred to, the highest quality of work is demanded, and the methods whereby this is obtained are as follows:

The rough-glazing operation is performed by hand, using compress leather wheels faced with No. 200 or F emery. These wheels are set up with a brush, there being sixteen successive coats of glue and abrasive applied in the building up of the head. In performing the rough-glazing operation, the blade is held on a piece of wood by means of pins, so that the operator has a handle which aids him in keeping the blade in the proper position relative to the face of the wheel. From time to time, a mixture of oil and abrasive is fed to the wheel, which is also dressed with tripoli cut cake at regular intervals. The wheels used for this operation are 18 inches in diameter, running at a speed of from 1100 to 1200 revolutions per minute. In rough-polishing the back and the tang of the blades, the same methods as described for the blade itself are used. Sharp corners and definite lines of contour must be carefully maintained, and when the work is done by hand, the skill of the operator is depended upon to produce a high quality of work.

The Finish-glazing Operation

For the finish-glazing operation, the larger blades are polished with FFF flour-emery, using compress canvas or leather wheels of medium density. The wheels are greased with cut cake during this operation, the purpose being to keep the wheels smooth and to prevent burning. From twelve to fifteen successive coats of abrasive and glue are used in setting up these wheels, and it requires about a day to set up a wheel.

For the smaller blades, the practice is somewhat different, because a harder wheel of a smaller diameter is required on account of the narrowness of the blades. The smaller wheel gives less contact, and is therefore more suitable for a narrow surface. These wheels are made of either canvas or felt, and are set up with five coats of grade F flour-emery and glue, each of which is applied with a brush and allowed to dry before the next coat is applied.

Both sides of the knife blades are colored, using an extra hard compress leather wheel. For coloring work, XF flour-emery is used, the wheels being set up with five coats, the first two mixed with larger proportions of glue than the last three. The emery cake used in the coloring operation is made of the same grade of emery as that used in heading the wheel, the emery being mixed with tallow in the manner well known in polishing work. The wheel diameter used for the coloring operation is 14 inches, the wheel running at a speed of 1800 revolutions per minute.

The next operation is to clean the blades with a tampico brush, after which they are buffed by a stitched buff made in five sections, using a nickel polish known as "Acme White" on the buff. These buffs are about 14 inches in diameter and run at a speed of 1800 revolutions per minute.

Some pocket-knife blades are crocus-polished on one side. In that case, they are polished on wood wheels having a bull-neck leather face. The face of this wheel is brushed over with a mixture of powdered crocus, water, and wood alcohol. Bull-neck leather is especially suitable for crocus polishing, because the porosity of this leather gives the wheel sufficient softness for this work. Wheels of this type are generally 20 inches in diameter, and are operated at the slow speed of 200 revolutions per minute.

The knife springs are roughed on hard density leather compress wheels headed with No. 200 grit emery for the inside of the springs; similar wheels, but headed with No. FF emery, are used for polishing. The illustration shows the polishing of the backs of assembled pocket-knives in the plant whose practice has been described.

Standards of Performance in Shop Work

By J. SETON GRAY, Industrial Engineer, A. O. Smith Corporation, Milwaukee, Wis.

THERE are too many questions decided on judgment—in many cases snap judgment; too often accurate knowledge of facts is lacking. No doubt the man making the decision bases it on experience, and in many cases comes pretty close to the facts; but why guess, when, if the work were studied, accurate knowledge would be available? Superintendents, foremen, and other shop executives must cultivate the habit of analyzing each job, and looking over the factors involved before actually making a decision or starting on a new project.

By the use of time and motion studies, it is possible to gain a thorough knowledge of, and to establish standard time on, any kind of work. These standards can be used as a reference to check up individual or departmental production. Regret has been expressed by many superintendents that they were unable to compare the production of one department with that of another, and yet this can generally be accomplished by the application of time-study methods and the establishment of standard production time.

There are standards of weight and of liquid and linear measurements. Why should there not be standards whereby the amount of labor or the amount of effort expended by men can be measured? When a man goes into a store to buy a pound of apples, he makes sure he gets a pound. Why should not an employer, when he purchases a certain amount of labor, be sure he is getting what he pays for; and, conversely, why should not a workman get remuneration in proportion to the effort spent in performing the work? Some form of standard is the only fair basis on which to compensate labor. It is fair to both employer and employe, and the fair-minded man, knowing how standards are arrived at, will appreciate this way of doing business.

It is becoming more and more the practice to establish "standard" time for the work to be performed in a shop. The standard time is the shortest possible time in which the work can be done. In establishing piece-work rates or bonus payments, an allowance is made, in addition to the standard time, for unavoidable delays and rest periods; but, by having a standard with which comparisons can be made, the estimated cost can be compared with the actual cost of all work being performed. If the difference between the estimated cost and the actual cost is too great, it is possible immediately to find out the reason why and to take steps to remedy the conditions at fault, so that excessive costs will not have to be contended with in the future.

The Time-study Method of Establishing a Standard

Assume that a unit of work is the amount of work that can be performed by the average competent man in one minute, allowing for the time required for productive work, rest, and abnormal conditions. Then, by time-study one can readily determine the units of work which must be expended to perform the necessary operations on any particular piece. In other words, a factory does not yield production, but units of work, and it is immaterial whether this work is performed on a watch or an automobile.

Find the number of units of work performed in any department, and also the cost of the unit of work in that particular department, by dividing the total payroll of the department by the total number of units of work performed. In this way, it is possible to set up a standard for the whole factory, so that comparisons can be made of the total factory production, month by month, or of the different individual departments. By this means, the relative efficiency of the various departments and of the departmental foremen may be shown. Carried far enough, one can determine the relative efficiency of different operators, and as every man usually believes in his own mind that he is as good as or better than anyone else, this is a method whereby it is possible to show him just how good he really is.

Different Kinds of Standards of Performance

Any kind of standard can be set up for comparative purposes. It is not essential that these standards be absolutely correct, so long as they are comparative. In the shipping department of one factory, where a great variety of material was handled, the unit finally adopted was the ton, regardless of whether the pieces were bulky or not. No effort had ever been made to establish a unit of comparison in this department previous to the time this unit was adopted. At one time it cost 71 cents to ship a ton of product; the following year the cost was brought down to 57 cents, and then to 48 cents; the last time this particular department was checked up, it cost 44 1/2 cents to ship a ton of production. Establishing a standard as something to "shoot" at, brought about these conditions.

In another factory where there was considerable trouble in furnishing crane and trucking service, good results were obtained by establishing a standard. No effort had ever been made to check the actual cost of this service, and to determine whether the efforts of these particular departments could be gaged. The product was rather diversified and complicated, and the factory spread over a large area, with the result that some pieces had to be trucked 69 times and handled by cranes 77 times before the finished product finally reached the shipping platform. The unit finally adopted was the ton of product produced, regardless of what it might consist of. As a standard, this left a great deal to be desired, but as a means of comparison, it worked out very well. Crane service that used to cost $1.05 per ton of production was brought down to 60 cents per ton of production in a little over a year's time. Trucking service, which cost 94 cents per ton of product, was brought down to 59 cents per ton in the same length of time. The service was not in any way impaired, but made even more efficient. Generally, it is surprising what a small percentage of the total available time trucks and cranes are actually under load.

The foregoing illustrations of shipping, trucking, and crane service illustrate what can be accomplished by analysis, investigation, and the setting up of standards, even when these standards are far from accurate. By using standards, a standard quality of product or service can be obtained much more readily than if no effort were made to check up the efforts of the men or departments.

Examples of Standards for Different Classes of Work

Departments, such as electrical maintenance, can be checked against the number of times other departments have had interruptions in service during the month on account of electrical or motor trouble, which information can be obtained from the foremen's daily reports, if in no other way. Oilers can be checked up by the number of hot bearings. In every case, there is some way to estab-

lish a comparison and create an incentive to do better in every department, even in the so-called non-productive departments. It only means making an investigation and setting a standard.

Sometimes one standard is not sufficient to create the proper incentive; one shipping department had standards of tonnage for production shipped, lumber used per car, and man-hours required to load a car. All these standards varied according to the type of car used; yet it is surprising how the law of averages works, and how an average car one month is very close to being the same as an average car the next month.

Always remember that whatever unit is selected as a standard for comparison, or for paying bonus or premium, it should be one that can be used to reduce or control costs. The object of standards is to reduce costs, making greater earnings for the company and consequently greater earnings for the men; for it is only fair that the men should participate in the savings made. Be sure, above all things, that the foremen and the shop men understand how the standards are arrived at. Results can only be achieved in proportion to the co-operative spirit that is fostered in the organization.

Standards of Performance must not be Arbitrarily Changed

When a standard has once been established, it should remain fixed, unless there is a change in the method of performing the work. It should, in fact, be guaranteed for the life of the job, or for a period of time such as a year, or six months. If such a guarantee is not given, and standards are changed, the men will lose all confidence in the management, and will say: "What's the use? You will not get a square deal anyway." Even if a standard once established is erroneous, it should be permitted to run for the guaranteed length of time, to establish and maintain the confidence of the men.

How Standards Aid in Efficiency Studies, Cost Estimating, and the Setting of Delivery Dates

The standard or best possible cost should be known for every piece manufactured; then the efficiency of the various departments may be determined by comparing the standard cost with the actual cost. In order to find out whether the department is improving or not, determine how close the actual cost comes to the standard cost; the closer the one approaches the other, the higher is the departmental efficiency.

If there is no predetermined schedule, it is impossible to adhere to promises of delivery dates; there is an overlapping of different jobs; and over-time is necessary to meet delivery dates. When standards have been applied, and the production from different machines and departments is known, it is a simple matter to set shipping dates with a reasonable amount of accuracy.

More and more it is becoming the habit to estimate costs before the work is actually performed—that is, to find out the shortest possible time it should take to perform the work. Then, when the work is done, if this estimated cost is not met, the reason should be determined and steps taken to remedy the condition so that it will not occur in the future.

Standards of Performance are of Value even when there is no Premium or Bonus Plan

Men on day work have no incentive to operate their machinery at maximum production. They are paid so much per day, regardless of their output. Day-work shops, where good production is obtained, are rare, and are generally dominated by some commanding personality who gets results in spite of handicaps. On day work, no effort is made to segregate the work performed by the individual men or the individual gang. Everything is generally "bunched," and if the foreman happens to be busy and unable to watch the gang closely, there may be more or less "soldiering." Where standards have been applied, such conditions are impossible.

Standards should be developed, so that the efforts not only of the men can be measured, but also of the foremen and the departments they are in charge of. Every cost the foremen can control should be standardized in some way so that the individual effort of the foremen can be gaged.

Analysis and investigations are necessary to create standards, but they also should be used for other things. All items that go toward creating increased cost of product should be investigated, and steps taken to tie them up on a standard basis. Supplies run into considerable money and should be proportional to the production in a department. Use can also be made of standards to check the scrap and rejections against production. Labor turnover, absentees, power consumption, machine repairs, and material used, should all be investigated and checked to see that these items are being controlled within the limits of production. In fact, it is impossible to run a department or a factory intelligently unless all items that go toward making costs can be measured and this can only be done by creating standards for every condition.

* * *

DETERMINING LENGTH OF BELTS

By THOMAS E. WELSH

On page 820 of June, 1925, MACHINERY appeared a table and formula for determining the length of sprocket chains. This formula and table can also be employed in calculating belt lengths. The only difference in the application of the formula is that the circumference, in inches, of the pulley is used instead of the number of sprocket teeth. The results closely approximate those obtained by the use of Rankin's formula:

$$\text{Length of belt} = 2C + \frac{11D + 11d}{7} + \frac{(D - d)^2}{4C}$$

given on page 722 of the fifth edition of MACHINERY'S HANDBOOK and on page 773 of the sixth revised edition. The following example will serve to illustrate the application of the formula.

Example—The center distance C between two shafts equals 40 inches, the diameter D of the larger pulley on one of the shafts equals 25 inches, and the diameter d of the smaller pulley on the other shaft equals 10 inches. Find the length of belt required.

Solution—Applying the formula given on page 820 of June MACHINERY, we have,

$$L = \frac{4C + (D + d) \times 3.1416}{2} + \frac{T}{C}$$

in which T is a value given in a table in the article referred to. Substituting numerical values in this formula we have,

$$\frac{160 + 109.956}{2} + \frac{5.699}{40} =$$
$$134.978 + 0.1424 = 135.120$$

As there are so many variable factors to be considered in the practical application of a belt for transmitting power from one shaft to another, any calculation of the belt length must be theoretical, but the result obtained with this formula is approximately correct. In this case, the length calculated is very nearly the same as that found by Rankin's formula previously referred to. The length, as calculated by Rankin's formula, is 136.40 inches. There is less difference in the results obtained with the two formulas when the pulleys are more nearly of the same diameter. For instance, in the case of a belt drive having a center distance of 50 inches and pulleys 42 and 30 inches in diameter, respectively, Rankin's formula gives the belt length as 213.86 inches, while the formula used in connection with the table on page 820 of June MACHINERY gives the length as 213.829 inches. The values for T given in the table simplify the application of the formula. Actually neither formula has any great advantage over the other as regards simplicity of application, but if both formulas are employed for a given problem, one serves as a check on the other.

Die and Assembling Fixture for Instrument Gears

By HOWARD M. GROFF, Treasurer, Buch-Groff Co., Trenton, N. J.

THE automatic piercing die shown in Fig. 1 has two features of particular interest, namely, the method employed for transferring the work from the magazine to the face of the die, and the method of locating it accurately before the punch performs the piercing operation. Before dealing with the design of this tool, it may be well to consider the requirements that prompted its design.

In the manufacture of certain delicate recording instruments, it is necessary to employ gears of exceedingly fine pitch in trains having high gear ratios. To secure an immediate response to an applied force in a train of gears, friction must be minimized. This is partly accomplished by the use of small delicate bearings and correspondingly small arbors for the gears.

Split Arbor for Holding Blanks

One of the requirements of gears such as here considered is a steady or uniform transfer of power. To accomplish this, the teeth are cut automatically with a fly cutter, the blank being indexed by an accurate spacing device. Obviously, the central hole in the blank, as shown in the enlarged view in the upper right-hand corner of Fig. 1, is too small to permit the gear to be adequately supported by an arbor during the tooth-cutting operation, and since this operation must be done as cheaply as is consistent with the required accuracy, the blank is prepared for the tooth-cutting operation by piercing or blanking out the spaces between the arms, leaving the central hole to be pierced in a later operation. The pieces thus blanked out are mounted on a split arbor, sixty at a time, and the teeth cut.

The outside diameter of the arbor used for the tooth-cutting operation is a good fit for the surface A of the rim of the blank. It has been found that, when the central hole and the spaces between the arms are pierced at one time, the pitch circle does not run true or concentric with the shaft, even when the teeth are cut with the work mounted on an accurate arbor, as described. It must be borne in mind that, due to the exceptionally fine pitch, the pitch circle must be concentric with the bearings within close limits of accuracy.

Formerly it was the practice to pierce the central hole for the arbor about 0.010 inch smaller than the finished size, and after cutting the teeth, mount each gear separately in a chuck. The chuck employed gripped the work on the finished tooth surfaces, so that the hole could be bored out true or concentric with the pitch circle. This method, although it generally gave good results, was too slow and sometimes caused the teeth to be marred or distorted.

Die for Piercing the Arbor Hole

The dies described in this article were designed to meet the requirements outlined in the preceding paragraphs. As the teeth were formed or finished on the top surfaces by the cutter, it was decided that a bell center descending in advance of the piercing punch and receding under spring pressure could be used to locate the gear under the center-piercing punch. Accuracy in the size of the hole was essential, as the arbor was required to be a good drive fit in the hole. The piercing die designed for this operation is shown in Fig. 1. The upper member, which carries the punch assembly and the cam K for operating the slide, is shown at U. The lower member Y, with the piercing die and the magazine feed, is shown in Figs. 1 and 3.

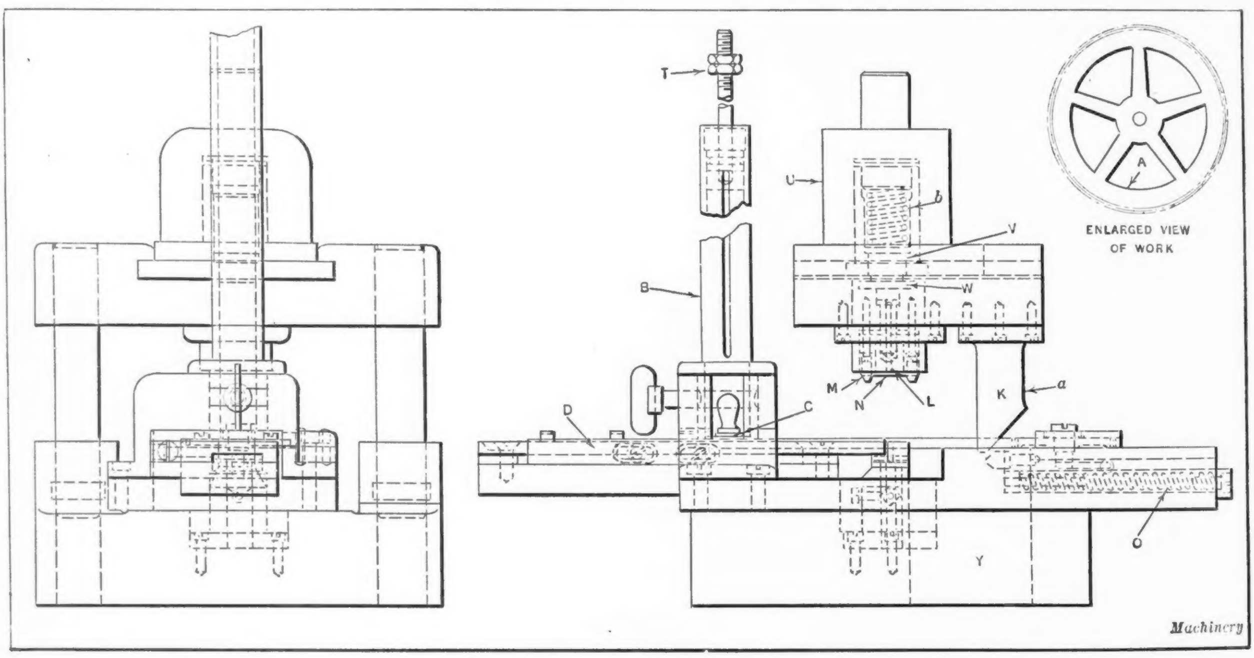


Fig. 1. Die for piercing Shaft Hole in Gear

Operation of Magazine Feed

The first step in placing the die shown in Fig. 1 in operation is to fill the magazine B with gear blanks and place the magazine in position on the die bed. The slide C is removed from the bottom of the magazine, allowing the gear at the bottom to rest on the surface on which it slides when fed into position under the piercing punch. The secondary slide D carries two thin members E, shown in the plan view of the die, Fig. 3, which are beveled at the edges and which come in contact with the gear teeth. These members centralize the blank when it is pushed under the punch. As the guide is

made slightly thinner than the gear, only one gear is transferred from the magazine to the piercing position at each stroke of the press.

The secondary slide *D* is connected to the primary slide *F* by the rack *G* and the compound gear *H* on the primary slide. One part of the compound gear meshes with the rack *J* on the opposite side of the primary slide, so that when cam *K*, held in the punch member, descends and pushes the primary slide backward, the gear rotates and imparts a movement of greater magnitude to the secondary slide; in other words, a 1-inch movement of the punch moves the gear a distance of about 3 inches from the magazine to a position directly under the piercing punch.

The approximate location of the gear under the piercing punch at the end of the movement of the feed slide is obtained by properly adjusting the screw *X*. The transfer movement described takes place before the piercing punch *L* and the bell center *M* which precedes it come in contact with the gear. The conical or beveled surface of the bell center accurately centers the gear under the piercing punch, after which the stripper *N* strikes the gear, clamping it securely while the punch *L* pierces the hole true with the pitch circle.

The bell center is milled away, as shown in the view in the upper right-hand corner of Fig. 2, in order to provide clearance for the transfer pieces *E*, Fig. 3. It will also be noticed that the cam *K*, Fig. 1, has a relieved portion above the end of the inclined face at *a*. This relieved portion causes the secondary slide and transfer pieces to recede slightly after reaching the end of the feeding stroke. This allows the gear to be moved in any direction by the bell center. If the cam *K* were not relieved at *a*, it is possible that the gear would be fed past the center of the die, in which case it could not be properly located by the bell center.

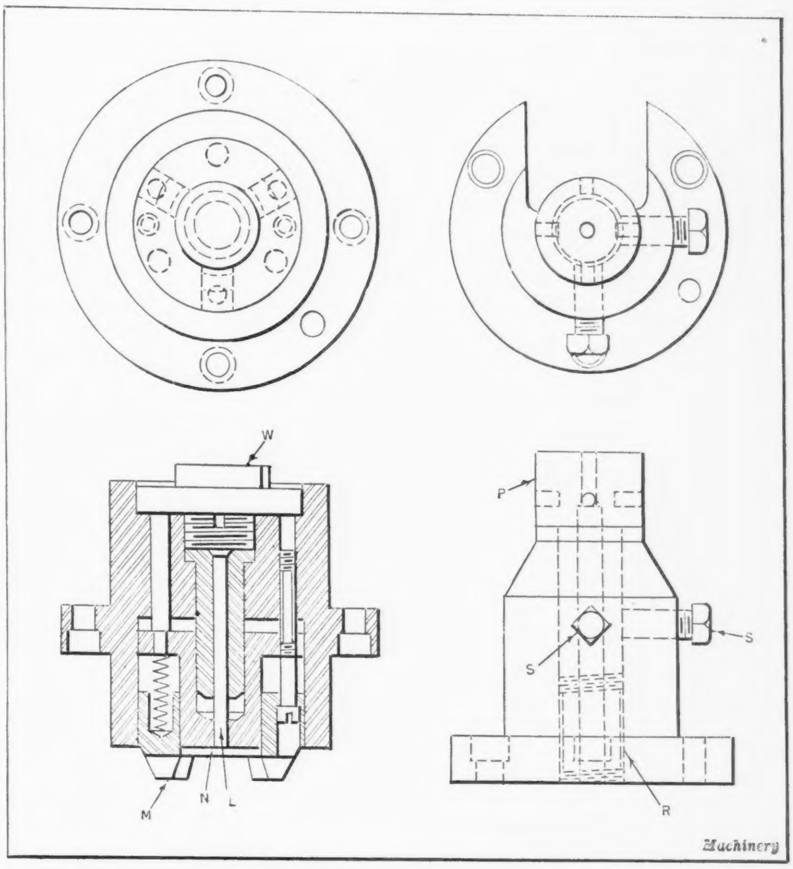


Fig. 2. Work-centering Punch and Die Members used in piercing Shaft Hole in Gear

On the up stroke, the spring *O* on the primary slide returns the feeding members to their former positions, and another gear is picked up and transferred to the piercing position, the pierced gear being pushed off the die by the gear which precedes it and dropped through an opening in *Y*.

Construction of Die Member

The construction of the punch and die members is shown clearly in the enlarged view, Fig. 2. The die *P* is threaded at *R* and can be turned or adjusted in the holder until its top surface is on a line with the lower surface of the transfer member. The die is locked in this position by means of the set-screws *S*. This adjustment insures a level and unbroken surface which permits the gear to be fed into place.

A weight *T*, Fig. 1, is placed on the top of the gears in the magazine to insure proper feeding. This weight also serves to close an electric circuit when it reaches the bottom of the magazine. The closing of this circuit operates an electric magnet which stops the press. Thus the press is automatically stopped when all the gears have been drawn from the magazine.

Design of Punch Member

The die is so designed that the punch, the die members, and the magazine can be easily removed from their holders. By providing suitable tools, one housing can be utilized for piercing several sizes of gears. Referring to Fig. 1, it will be noted that there is no direct connection between the spring *b* in the stem of the holder *U* and the stripper which surrounds the punch. The stem is a floating member carried in a T-slot in the punch-holder, and for this reason it will not become cramped on the pillars as the result of play in the punch slide. The button *V* projects downward and makes contact with button *W* carried in the punch body, when the stem and punch-holder are properly located or aligned with each other. One of these buttons is larger in diameter than the other one, so that some misalignment of the stem and punch slide may exist without impairing the transfer of spring pressure to the stripper *N*.

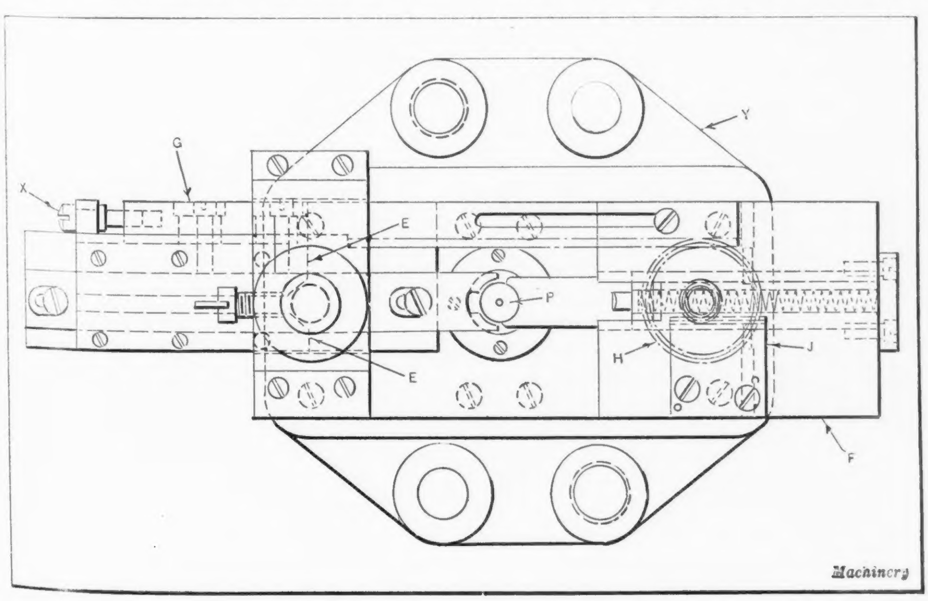


Fig. 3. Plan View of Die, showing Automatic Feeding Mechanism

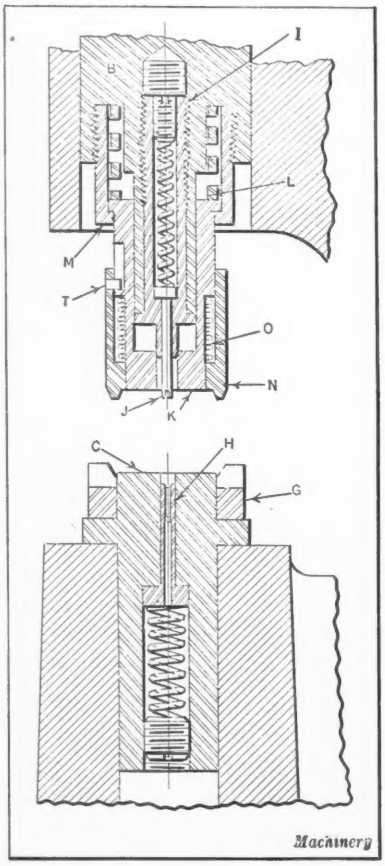


Fig. 4. Cross-section of Shaft and Gear Assembling Dies

In cases where it is desired to locate holes accurately in a piece having an irregular contour, a bell center having a contour which matches that of the work is employed. When the work is placed on the face of the die by hand, limiting or gage pins can be used to locate the part within 1/32 inch of the exact piercing position. These pins should be so arranged that they will prevent the work from being placed on the die in a reverse or incorrect position. As the ram descends, the centering device accurately locates the work and holds it until clamped securely in place by the pressure ring which precedes the piercing punch. This method of locating the work is faster than the usual method in which the work is placed in a tightly fitting profile cage or nest. When the latter method is used, a piece frequently becomes wedged in the locating nest and time is lost in removing it. With the improved method, no difficulty of this kind is experienced.

Assembling Fixture

In order to maintain accuracy in assembling the gears on the pinion shaft, as shown at *A*, Fig. 5, it was found necessary to employ the assembling fixture shown in Fig. 6. This fixture drives the pinion shaft from the position shown at *B*, Fig. 5, down through the hole in the gear until it is properly seated as shown at *A*. The features embodied in this fixture are a self-centering device for the gear, a self-centering device for the pinion and shaft, and means for clamping the wheel or gear in a central position while the shaft is being driven into place.

The assembling fixture consists essentially of a base *A*, Fig. 6, carrying a plunger *B* and die *C*. A link arrangement consisting of straps *D*, yoke *E*, and the forked handle *F* is employed to operate the plunger *B*. The plunger is returned to its normal position by the spring *S* when the operating handle is released. Die *C* carries a taper guide or locating nest *G*, which locates the gear in approximately a central position over the die base. The details of these members are shown in the cross-sectional view, Fig. 4. The method of locating the work employed in this fixture permits rapid operation, as it is only necessary for the operator to drop the work in the loose-fitting nest *G*.

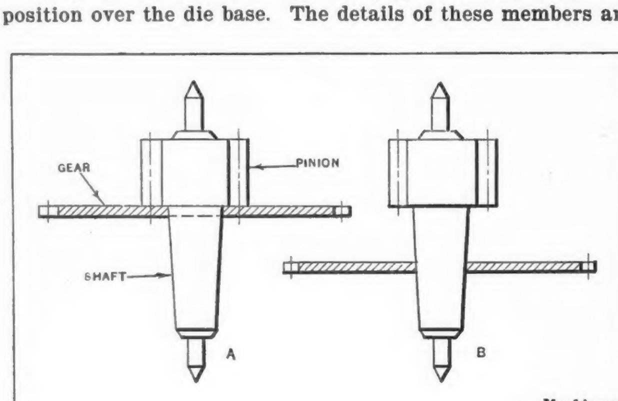


Fig. 5. Pinion Shaft and Gear

Within the die is a spring plunger *H* which engages the lower pivot of the pinion shaft. Secured to the end of plunger *B* is the driving punch *I* in which is located the spring plunger *J* that engages the upper pivot of the pinion shaft. Surrounding plunger *J* is a pressure pad *K* which is backed up by the spring *L*. This pressure pad is secured to the plunger by means of the cap *M*. Pressure pad *K* is provided

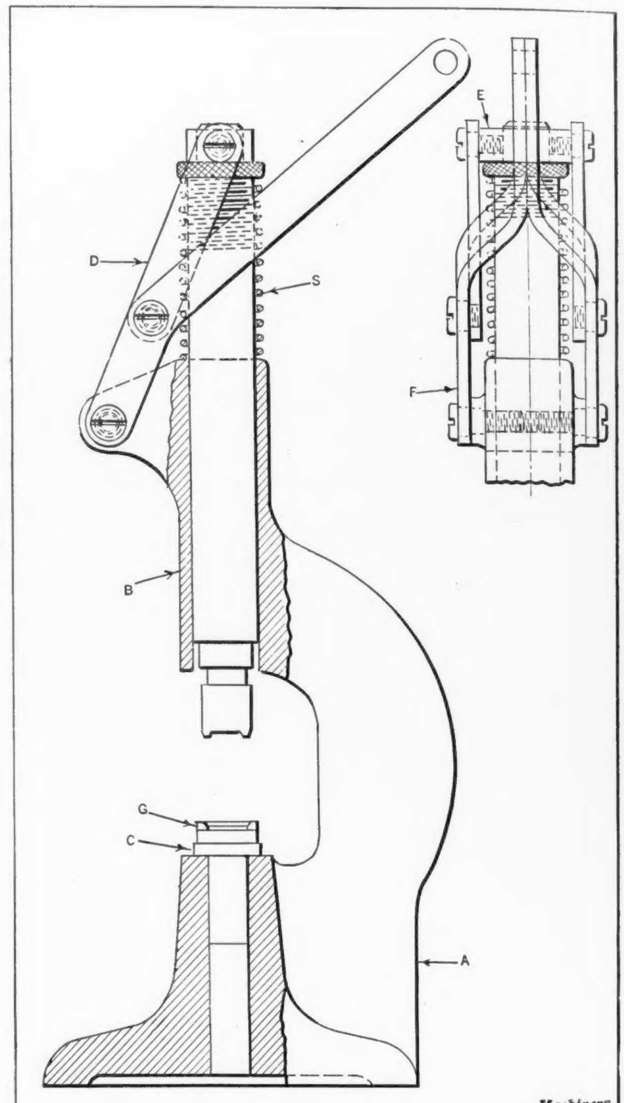


Fig. 6. Fixture for assembling Shaft and Gear shown in Fig. 5

with a bell center *N* backed up by a spring *O* which returns the center to its position a little in advance of the face of the pressure pad on the upward movement of the plunger. A key *T* serves to prevent the bell center *N* from turning on the pad *K* or from dropping off.

Assembling Gear on Pinion Shaft

The operation of driving the pinion shaft into a gear is described in the following: The operator places a gear upon the face of the die in approximately a central position, picks up a shaft with a pair of tweezers, and places the lower end or pivot in the center hole of plunger *H*. The plunger *B* is then lowered until the upper pivot of the pinion shaft engages the plunger *J*. When the operating members of the fixture are in this position, the shaft is held in a vertical position and in true alignment with the center of the die.

Upon removing the tweezers and continuing the downward stroke of the plunger, the gear is engaged at its outer edge by the bell center, which, backed up by the light spring *O*

to prevent injury to the work, is drawn to a central position on the die. The face of the pressure pad *K*, which is backed up by a heavy spring *L*, clamps the gear in its true central position on the face of the die before the driving punch engages the shoulder on the pinion shaft. During the last part of the downward movement, the punch *I* comes in contact with the shoulder on the pinion shaft and drives the latter member down until the pinion is in contact with the gear, as shown in the view at *A*, Fig. 5. The handle is then released and the plunger returns to the position shown in Fig. 6, after which the assembled pinion and gear are removed from the die member.

* * *

THE "STANDARD COST" SYSTEM

The Department of Manufacture of the Chamber of Commerce of the United States, Washington, D. C., has just issued a pamphlet dealing with the subject of cost accounting. Actual experiences of manufacturers who have employed "standard cost" systems, and a general description of the various methods used, are included in this pamphlet. As explained in the pamphlet, a "standard cost" system is one that employs predetermined figures in the accounting in place of actual costs of products. In a standard cost system, the sum total of the standard costs of goods produced is compared with the total outlay in money during the period of such production. The procedure is the reverse of that employed in the job cost system. In the latter, the actual costs are allotted to the individual products or lots. In a standard cost system cost values are assigned to the products and the total of such assigned values compared with actual outlay of production.

According to the pamphlet, cost accounting through the use of standards is gaining in favor with executives and accountants. During the last few years, it is stated, numerous cost systems employing standards or predetermined cost figures have been devised and put to satisfactory use, but generally, there is no uniformity of practice under the method.

Copies of the pamphlet can be obtained by applying to the Department of Manufacture, Chamber of Commerce of the United States, Washington, D. C.

MOVING AN OPEN-SIDE PLANER

Improper methods of moving machine tools about the shop often result in serious damage to the machines. There have been instances where heavy machines, such as planers, have dropped to the floor, while being transported by overhead cranes, and broken beyond repair. One of the most awkward machines to move by the use of a crane is the open-side planer. As there is a heavy column on only one side of the bed and table, when an attempt is made to lift the machine by means of the bed, there is a tendency for the machine to be turned upside down.

The accompanying illustrations show the method used in the shop of the Cincinnati Planer Co., Cincinnati, Ohio, in moving planers of the open-side type. Two rope slings of equal lengths are passed around the bed and over hooks attached to an overhead beam, as illustrated in Fig. 1. A third rope sling is passed from the link of the overhead beam down through a hole in the back of the column, as shown in Fig. 2, then through a hole directly opposite on the front side of the column, and back to the link of the overhead beam. This third sling prevents the column from tipping over when the planer is lifted. The link of the overhead beam is suspended from the hook of the traveling crane in such a manner that the beam can swivel sufficiently to balance the machine as it is lifted.

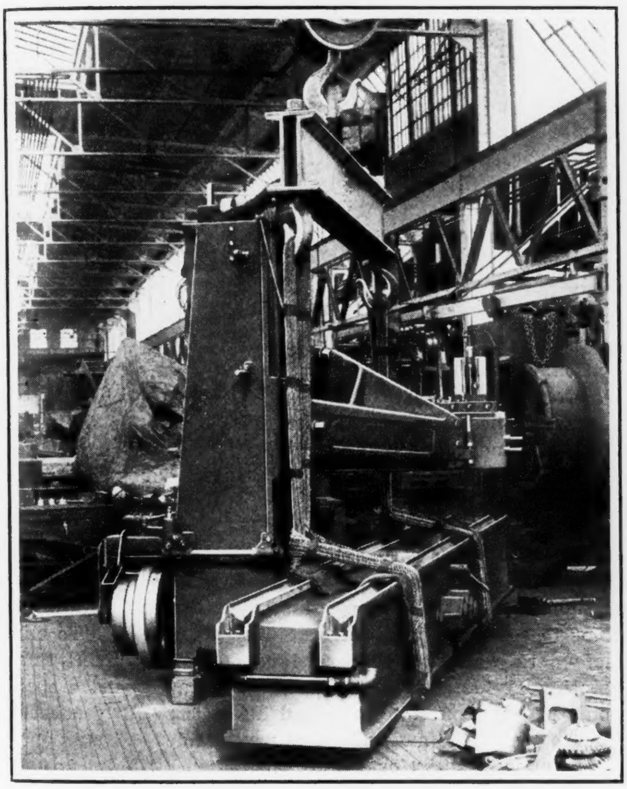


Fig. 1. Holding an Open-side Planer by Two Rope Slings around the Bed for transporting it with an Overhead Crane

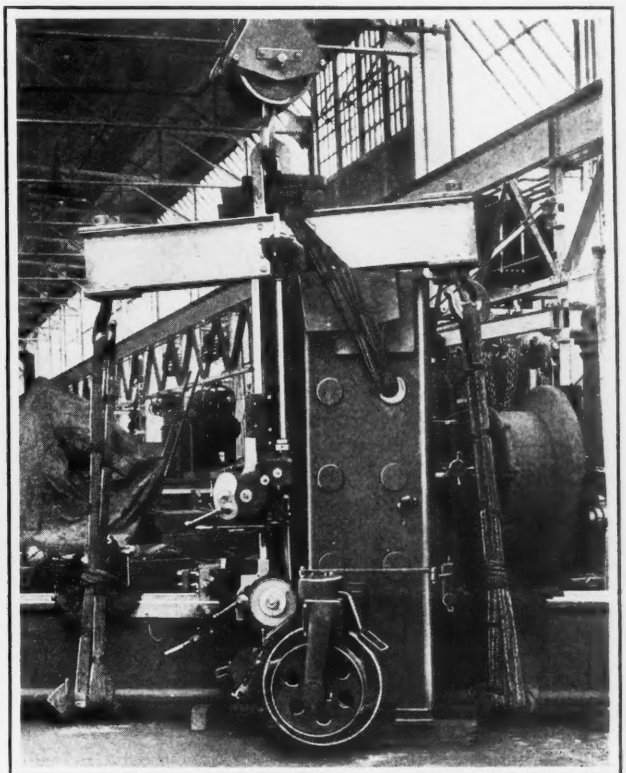


Fig. 2. Illustration showing the Third Sling which holds the Column Upright as the Planer is raised from the Floor

* * *

THE NAVY NEEDS DRAFTSMEN

The United States Civil Service Commission has announced that the Washington and Norfolk Navy Yards are in immediate need of a considerable number of detail and designing draftsmen. The detail draftsmen are needed for engine and boiler work and for electrical and ship piping work. The salaries for this class range from $5.84 to $7.60 a day. Designing draftsmen are needed for ship design and ship piping work. The salaries in this class range from $8.08 to $10.16 a day. Applicants will be rated on their education, experience, fitness, and specimens of their work. Full information and application blanks may be obtained from the Secretary of the Fourth United States Civil Service District, 1723 F St., N. W., Washington, D. C.

MAINTENANCE OF FACTORY WALLS

By C. C. HERMANN

There is a great variation in the life of factory walls caused principally by continued neglect in their maintenance. For example, brick walls should have a life of fifty years, but due to neglect, this is often reduced to thirty years. The higher figure prevails when the wall is gone over yearly and all cracks "pointed up," in addition to periodically pointing up the entire wall. Unless this is done, moisture enters the cracks, softening the brick and causing the wall to crumble long before its normal life has been completed. The wall pressure is normally uniform over each square inch of the wall; hence, when the bricks are undermined by the elements, they usually fail quickly.

Maintenance of Factory Walls by "Pointing"

Pointing brick walls is a very important maintenance problem, and should be entrusted to experienced brick masons only. The mixture for pointing should be 1 to 2 Portland cement mortar, with a lump of lime about the size of a hen's egg to each bucket of mortar to make it work easily and set readily. The cost of pointing walls will vary, but under average conditions it should not exceed $1.50 per 100 square feet.

Another troublesome matter in connection with walls is seepage. During the spring months, in particular, basement walls may be responsible for considerable loss and damage to the building as well as the stock contained therein. The basement wall is generally the very base of the wall, and carries the entire wall load, in addition to the roof and floor loads. Should this portion of the wall become saturated with moisture, its strength will be materially reduced and failure may result. The ground outside the wall contains considerable water, and sufficient pressure often accumulates to force the water through walls of ordinary construction. This is particularly true of brick walls and at least in part true of concrete walls. However, concrete, when properly proportioned and mixed, forms a fair resistance against moisture, but even this material eventually permits moisture to find its way into the building unless some precaution is taken to exclude it.

Waterproofing Factory Walls

Times without number, the mistake has been made of applying waterproofing to the interior of a wall. In fact, in most cases, this is the best that can be done. However, there is no question that the more economical way is to apply it to the outside of the wall. This necessitates digging down to the base along the outside. On new buildings, it is now the practice to apply the waterproofing before the back fill has been made on the foundation walls. To apply it on the interior of the wall solves only one-half the problem. The stock may be thus protected, but how about the wall? The wall is subjected to the moisture just the same, and is weakened just as much.

Treating Old Factory Walls

In waterproofing an old wall, the surface must first be thoroughly cleaned and chipped, in order to obtain a perfect bond with the wall. After the chipping operation, all dust must be removed by washing. The waterproofing should be applied as soon as possible after the wall has been prepared; otherwise, dust and particles of matter will settle on the wall out of the atmosphere, preventing a bond between the waterproofing and the wall. If the wall contains grease stains, these should be chipped extra deep and then washed with naphtha. The first coat over such grease stains should be a heavy grout of cement. Some waterproofing may be mixed in with the grout, and then the regular coat of waterproof applied over this.

The amount or thickness of the waterproofing will depend on the depth below grade that it is applied and upon the pressure exerted by the water beyond the wall. Generally speaking, however, waterproofing is more a matter of low pressures, and full dependence is placed on the wall to withstand the pressure. Two or even three heavy coats should be applied, each coat not over 5/16 inch thick, and troweled to an even finish, smooth and free from imperfections that might impair the moisture-resisting property.

Painting Outside of Factories

Sheet steel or corrugated walls, as well as frame buildings, possess maintenance problems that must be given attention. For example, corrugated steel walls require a coat of protective paint occasionally in order to avoid oxidation. An asphalt paint is best for this purpose, as it bonds readily to the steel surface, preventing it from rusting. The writer's experience indicates that this type of wall should be painted at least once each year. The steel sheets will deteriorate around the bottom edge first, due to close contact with the ground and the electrolytic action which rapidly eats away the steel.

The life of wooden structures is determined to a considerable extent by the frequency with which they are painted. They should be painted every second or third year, depending upon the grade of paint used. The most costly item in painting a building is the labor; therefore, the use of cheap paint is false economy.

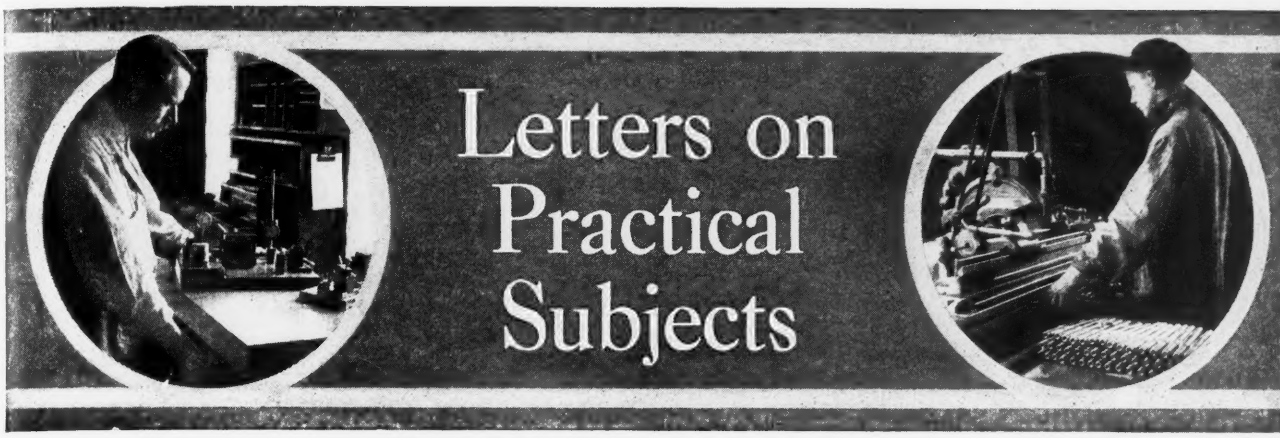
Regardless of the construction, walls have one common function, and that is to keep out the cold. Numerous cracks and crevices develop from time to time which permit the cold to creep into the building. A little time devoted to an inspection of the wall for this purpose alone will more than repay the effort. All places to be calked should be marked, in order to save time when the calking begins. Wooden windows and door frames will be found to require the most attention. If an instrument could be used to measure the cold air filtering through these places, it would reveal a surprisingly large heat loss. The writer has used an asbestos fiber bitumen cement with considerable success, which is forced into the cracks by the use of a gun manufactured for this purpose.

Just as natural light is preferable to artificial light, and should be taken into consideration in the original construction of a building by providing windows wherever possible, so should dark walls be eliminated within the building in order to conserve the light that finds its way in. To eliminate dark walls, all that need be done is to paint them. Painting by hand methods, however, is an expensive operation, and the scaffolding required interferes with production more or less. The most practical way yet devised is to apply the paint by a spray or air brush. When oil paint is used, the air brush is the most practical method. Many factories use whitewash, and in this case, an air tank with an air pressure of 60 pounds and an air hose equipped with a mixing connection serves the purpose.

* * *

THE ECONOMY OF NEW ENGINEERING EQUIPMENT

It is not only in the machine shop field that great savings are made by the installation of modern equipment. In all fields of engineering, modern equipment is so much more economical than older types that new installations become distinctly profitable. Two examples of this may be mentioned. A turbine-driven centrifugal pump was recently installed at the municipal pumping station at South Bend, Ind., replacing two steam pumps which had worn out in service. The present turbine installation saves the city about $3200 a year in steam over the cost of steam required for the old equipment. This saving practically equals the fixed charges and operating expenses of the new equipment. As another example may be mentioned a General Electric turbine generator used in the plant of the Northern Paper Mills, Green Bay, Wis., for generating electricity and for furnishing low-pressure steam. The total saving per year, compared with the cost of operating the old equipment replaced by the turbine generator, is stated to be approximately $40,000.



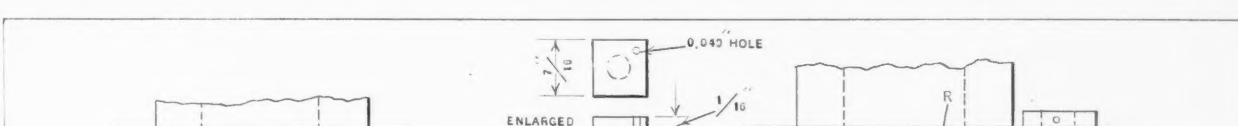
DIE FOR PIERCING SMALL BRASS PARTS

The 0.040-inch holes in small brass pieces like the one shown at *A* in the accompanying illustration, were first pierced in a simple die. The punch consisted of a short length of 0.040-inch drill rod held in a small spring collet which was secured to the gate of the press. The work was supported in a V-shaped die. As these small brass pieces were used in a mechanism that sold at a very low price, it was found necessary to obtain a 75 per cent increase in the production rate, in order to compete successfully with other manufacturers. This increase was obtained with the self-feeding die shown in the illustration.

When the self-feeding die is in operation, the workman simply places a quantity of the small brass pieces on the pan (not shown) which is secured to the upper end of the feed-chute *B*, and slides the pieces from the pan into the chute, small end first. The pieces are fed down the chute by gravity until they come in contact with the stop-pin *C*. As the press ram descends, the work is carried up against the die *D*, through the action of rod *E* on the transfer arm *F*. The rod *E*, coming in contact with the projecting end of arm *F*, causes the latter member to pivot on pin *G*. A further downward movement results in carrying the piece of work *W* to approximately the position shown by the dotted lines at *Y*.

As the press ram continues downward, the flattening punch or pad *H*, backed up by the spring *I*, presses down on the work, and the hole is pierced by punch *J*. Pad *H* holds the work firmly, and prevents the head from being distorted while being pierced. The stop *C* is also backed up by a spring which compensates for any variation in the length of the work. The rod *E*, which actuates the transfer arm, is backed up by the spring *K*. This construction permits rod *E* to slide upward in bushing *L*, if a piece of work becomes jammed in the die, and thus prevents breaking or damaging the die. The key *M*, fitted in the rod *E*, is a sliding fit in the keyway in the bushing *L*, and serves to prevent rod *E* from turning.

As the press ram ascends, the rod *E* moves upward and allows the spring *N* to bring the transfer arm back to the position shown, so that a new piece of work is allowed to slide down into place. A stream of air directed against the side of the work ejects it from the die. The stream of air is conducted to the desired point through a 1/8-inch tube, and is controlled by the regular button air valve mechanism. The spring which backs up the stop *C* serves to loosen the work from the die before it is ejected by the stream of air.



Self-feeding Piercing Die for handling Small Brass Parts in Quantities

The cap *P*, which holds the pad *H*, punch *J*, spring *I*, and sleeve *R* in position, is secured to the body of the punch by a bayonet lock, and is prevented from turning or loosening by the locking device shown at *S*. The inserted die *D* is held in place by pins *T* having beveled ends, which are clamped against beveled surfaces on the die by tightening the set-screws *U*. By loosening these set-screws, the inserted die is released and can be easily removed. The end view *Z* of the transfer arm *F* shows how this member is notched out to receive the work.

Bridgeport, Conn. JOSEPH E. FENNO

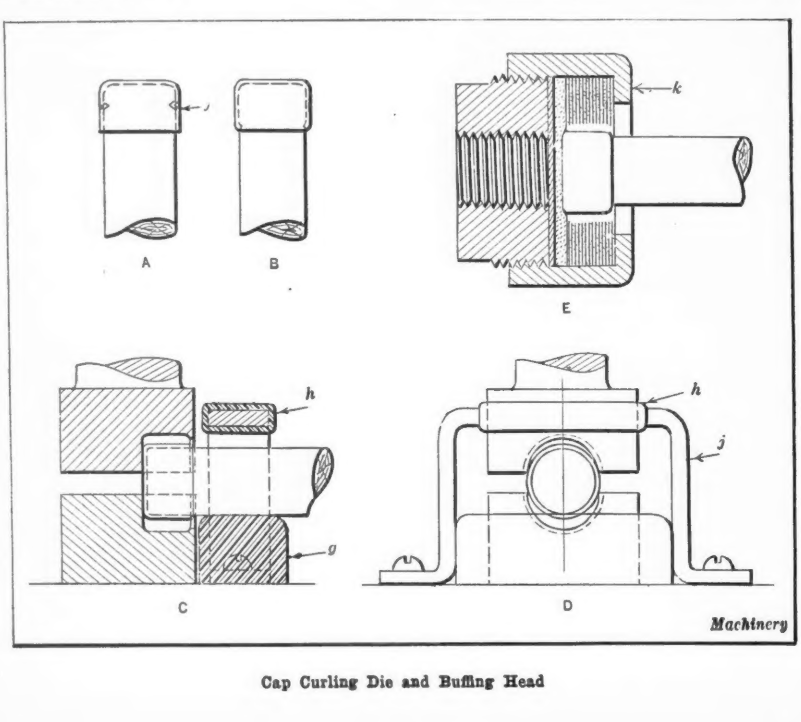
CAP CURLING DIE AND BUFFING HEAD

The brass-capped wooden rod shown at *A* in the illustration was redesigned as shown at *B* in order to simplify its manufacture. With the latter design, it is unnecessary to trim the open end of the cap, as the irregularly drawn rim is curled into the wood. This also makes it unnecessary to indent the cap, as indicated at *f*, in order to secure it to the rod. The new method also gives the work an improved appearance. As the length of the rod made it impractical to use a curling die of the usual vertical type, the horizontal design shown at *C* and *D* was employed.

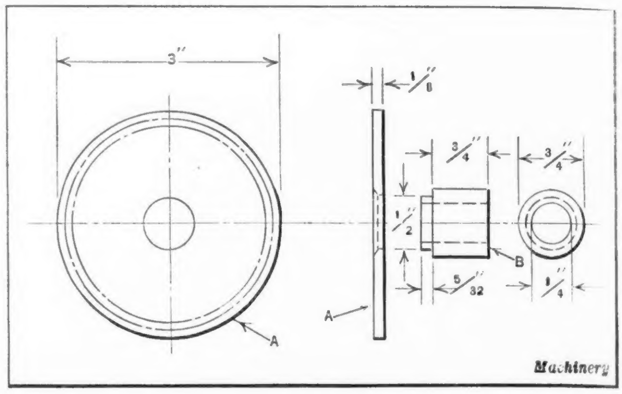
The design of the punch and die, each of which is made from one piece of steel, is clearly shown in the illustration In making the punch and die, the blocks were clamped together on the faceplate of a lathe and bored out to conform to the shape of the outside of the curled cap. After being hardened, the punch and die were again secured to the faceplate in a similar manner, and their recesses carefully polished. As no knockout is embodied in the die, the rubber pad *g* serves to lift the cap from the die, and the stripper *h* sheds the cap from the ascending punch.

The cap, which is a snug fit on the rod, is located in the die as shown at *C*. When the punch descends, it carries the cap and the rod down into the die, and at the end of the stroke, drives the rim into the wood. As the punch ascends, the compressed rubber pad *g* lifts the rod and cap from the die, and when the rod comes in contact with the rubber pad *h*, on the stripper *j*, it frees the cap from the punch. The buffing head shown at *E*, which is employed to remove the die marks from the caps, is mounted on the spindle of a bench grinder. The head contains a felt pad and a series of canvas rings which are charged with polishing powder. The capped rods are thrust into the head, which gives them a high polish. The cap can be unscrewed and the buffs quickly replaced when necessary.

Brooklyn, N. Y. S. A. McDONALD



Cap Curling Die and Buffing Head



Details of Small Two-part Gear

CONSTRUCTING TWO-PART GEARS

Two-part steel gears are used extensively in the manufacture of adding machines, vending machines, and toys. The separate members of a two-part gear are shown in the accompanying illustration. The outer part on which the gear teeth are cut is shown at *A*, and the part that forms the hub at *B*. The two members are held securely together by riveting. This method of making small steel gears is, in most cases, more economical than making them in one piece.

The procedure followed in one plant in manufacturing two-part gears of the design shown in the illustration, in lots of 5000, is described in the following. An order of 5000 gears of this kind is large enough to warrant the making of punch press tools for producing the gear blank, but is hardly large enough to warrant making a die that will punch out the gear teeth unless large repeat orders are assured. Also, it must be borne in mind that punched gear teeth are not entirely suitable for all purposes.

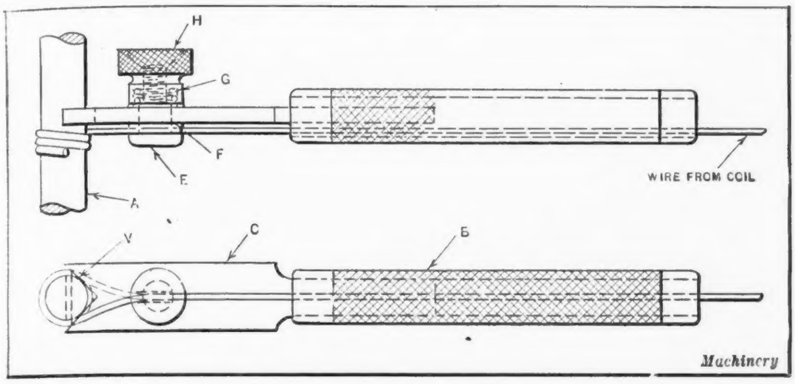
We will assume that the teeth are cut in the blanks, either in a gear-cutting machine or a milling machine. In either case, two or more machines may be operated by one man. A lot of 50 gears may be cut at one setting by mounting the blanks on a shouldered arbor, clamping them together tightly by means of the arbor nut, and then cutting the assembled blanks as if they were a solid gear. The gears are next countersunk for riveting, by holding them in some simple fixture placed on the table of an upright drilling machine.

While the outer members are being machined, the gear hubs can be made on an automatic screw machine. The shouldered end should be about 1/32 inch longer than the thickness of the gear to provide sufficient stock for riveting. The hole in the gear hub should be countersunk, so that it will not be damaged by the riveting operation. The parts are assembled by the aid of a hand press, and the riveting is accomplished in a riveting machine. The surplus stock that remains after the latter operation has been performed can be removed by holding the assembled gear against a disk wheel. The methods of assembling here described, may be employed in the manufacture of other parts such as levers, links, cams, ratchets, and pawls. In some cases, machine side frames may be made by riveting shouldered bushings to a thin frame to form suitable bearings for the shafts.

Pawtucket, R. I. S. W. BROWN

TOOL FOR WINDING HELICAL SPRINGS

The writer read with interest the article entitled "Points on Winding Helical Springs," on page 400 of January MACHINERY. In the accompanying illustration is shown another tool for winding springs, which the writer developed and used for a number of years.



Tool for winding Helical Springs

This type of winder may be used without supporting the rear end of the winding mandrel *A* by means of the tailstock center. The tool is held entirely by hand, and the spindle can be run at a very high speed. The V-groove in the end of the tool permits the winding of either right- or left-hand springs by simply reversing the direction of spindle rotation.

The knurled handle *B* consists of a piece of tubing knurled on the outside. The wire passes through the body of the handle, and therefore does not interfere with the operator. The part *C* is made of tool steel, and the end at *V* is hardened to prevent wear. Part *C* is made a light drive fit in handle *B*. The tool-steel stud *E* and the washer *F* are also hardened to prevent grooves from being worn in them by the passage of the wire. The knurled-head nut *H* is recessed on the under side to receive a short, but strong, helical spring *G*, the function of which is to maintain a uniform pressure on the wire, regardless of the slight irregularities in its diameter.

For winding a tight spring, either right- or left-hand, it is only necessary to start the machine spindle rotating in the required direction and exert a slight pressure on the winding tool in the direction of the driving end of the mandrel. For winding o[illegible] rings, a separator of the proper thickness is held against the mandrel with the left hand, while the winding tool is held in the right hand. The separator is also made with a V-groove in the end which keeps it in the proper position as it follows the helical path formed by the spring.

A drill press, bench lathe, or almost any machine provided with a chuck for holding the mandrel and equipped for driving the mandrel in the required direction can be used for winding springs with the tool described. Excellent springs can also be made by attaching a lathe dog to the mandrel and using this as a handle for rotating the mandrel by hand.

York, Pa. L. C. GARVIN

SPECIAL TOOL EQUIPMENT FOR TURRET LATHE JOB

The set-up shown in the accompanying illustration has several features of interest to toolmakers and tool designers. The casting shown by the dot-and-dash lines is chucked in a Warner & Swasey turret lathe. An old two-jaw box chuck *A*, one jaw of which has been removed to accommodate an angle-plate *B* is employed to hold the work. The angle-plate is fastened to the chuck body as shown, and serves to hold the casting *C*, which is located by the two pins *D*. The removable jaw *E* is provided with a false jaw *F*, which is shaped to fit the casting. This jaw clamps the work tightly against the angle-plate.

The machining operations on the casting consist of trepanning one side and finishing the seat for a glass window. The tool *G* is used to remove the scale from the casting before the tool *H* is employed. The latter tool is shown in the enlarged end view at *W*. The cutting ends *J* of the trepanning tools are ground in much the same manner as a cutting-off tool, the amount of clearance required to adapt the tools for circular cutting being provided at *K*. After the trepanning operation, the seat is finished by reamer *L*.

New York City B. J. STERN

SETTING COMPOUND REST FOR SPHERICAL TURNING

Nearly all machinists have had occasion to turn spherical work by employing the compound rest as a pivoting tool-holder, but they generally depend upon a cut-and-try method for locating the pivot of the compound rest in line with the lathe spindle. This takes time, and often the work is machined under size before the rest has been properly centered. The following procedure, however, eliminates the cut-and-try method and enables the compound rest to be quickly and accurately centered.

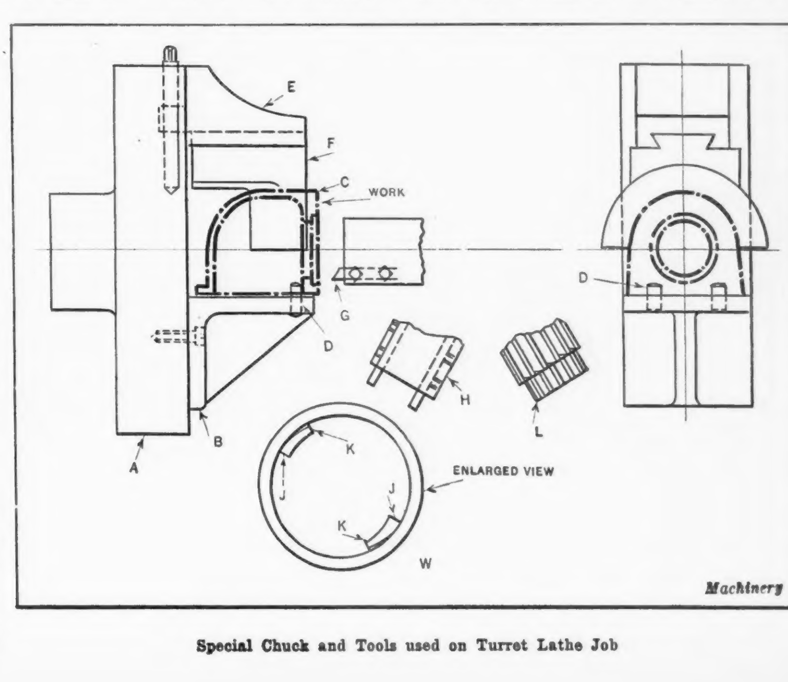
First an indicator is clamped to the toolpost, and the compound rest located as nearly in the central position as possible without taking measurements. The indicator is then brought into contact with the center holder of the tailstock and the reading noted. Next, the tailstock center is removed, the compound rest revolved through an angle of 180 degrees, and a reading taken on the opposite side of the tailstock spindle. If there is a difference between the readings, the cross-slide is moved over an amount equal to one-half the difference in the dial readings to bring the pivot in line with the lathe spindle. The indicator point must, of course, make contact near the end of the tailstock spindle in order to permit the carriage to be revolved through an angle of 180 degrees.

When the tailstock spindle is not accurate enough for locating purposes or is not located in line with the lathe spindle, a piece of steel can be clamped in the chuck jaws, turned down at the end, and used in place of the tailstock spindle for centering.

Philadelphia, Pa. CHARLES KUGLER

MAKING A SHEET-STEEL REDUCING ELL

In Fig. 1 is shown a special ell made from No. 8 gage sheet steel. This ell has a radius of 49 inches, is 18 inches in diameter at the large end, and 12 inches in diameter at the small end. The first step in producing this piece was to make a lay-out like the one shown in Fig. 2, one-fourth the size of the completed work. By scaling the drawing, the dis-



Special Chuck and Tools used on Turret Lathe Job

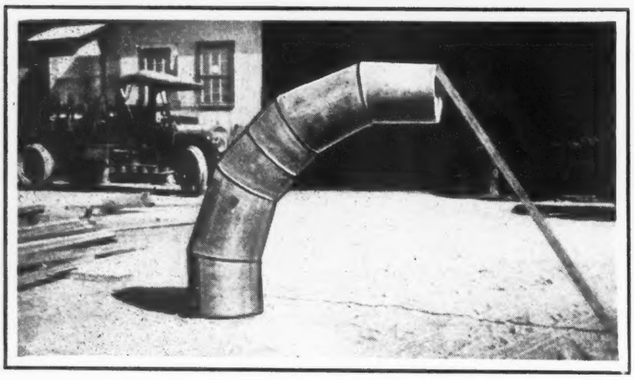


Fig. 1. Completed Sheet-steel Reducing Ell

tance through the center was found to be 6 1/2 feet. A tapered pipe 12 inches in diameter at the small end, 18 inches in diameter at the large end, and 7 feet long, as indicated in the diagram at the left-hand side of the illustration, was rolled to shape from No. 8 gage sheet steel and acetylene-welded at the seams. It was necessary to make this tapered pipe in two sections, as the material was not long enough to permit forming the pipe in one piece. By making the pipe 7 feet long, a length of 3 inches was available at each end for fitting.

Two longitudinal lines *A–A* and *B–B*, diametrically opposite, were drawn the full length of the pipe and center-punched. These lines were used to locate the pipe when cutting and welding. A lathe faceplate 20 inches in diameter was placed on the floor-plate of a radial drill and blocked up on one side to an angle of 11 1/4 degrees, which is the angle of the first cut to be made on the pipe. Then a line was scribed across the faceplate from the low side to the high side. The large end of the tapered pipe was next placed on the faceplate with the lines *A–A* and *B–B* coinciding with the line scribed on the faceplate. Then the line for the first cut was laid off with a surface gage placed on the floor-plate of the radial drill. The pipe was cut off on this line with an acetylene torch.

The faceplate was next tilted to an angle of 22 1/2 degrees for cutting the next three pieces. The tapered pipe, large end down, was placed on the floor-plate with the lines *A–A* and *B–B* coinciding with the line scribed on the faceplate, but turned half way around from the position in which the first cut was marked off. Part No. 2 was then marked off and cut with the torch. The same procedure was followed in cutting parts Nos. 3, 4, and 5, it simply being a matter of turning the pipe half way around after each cut. After all the parts were cut to length they were joined together by acetylene welding with the lines *A–A* coinciding with the lines *B–B* in each altered section. This method of making a reducing ell results in very little waste of stock and simplifies the laying-out problem.

Lancaster, Cal. STANLEY P. GOULD

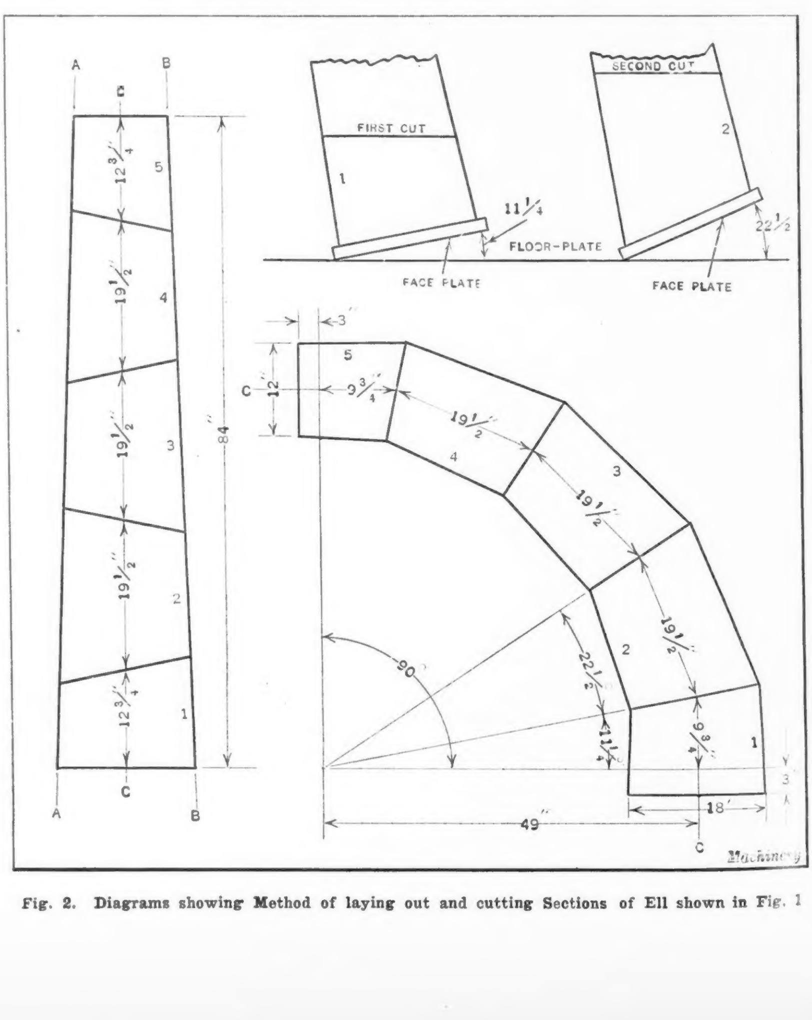


Fig. 2. Diagrams showing Method of laying out and cutting Sections of Ell shown in Fig. 1

DETERMINING TEMPERING TEMPERATURE WITH SOLDER

In drawing the temper of tools and dies, a piece of soft solder will serve as a safeguard when more elaborate means of judging the temperature are not available. A flat plate of suitable size is heated to a red heat, and the die or tool placed on this plate after it has been hardened. The correct temper may then be indicated by applying the solder to the work at frequent intervals and in several spots or in a location where the temper is desired. When the piece has reached the temperature at which the solder just begins to stick, further heating should be stopped by plunging the work into the cooling bath. This method gives a temper equal to that known as "dark brown" or "straw" color, and is particularly well suited for small shops with limited equipment. It can also be used to good advantage in places where the light is not good for judging colors or by workmen who have poor eyesight.

Seneca Falls, N. Y. H. L. WHEELER

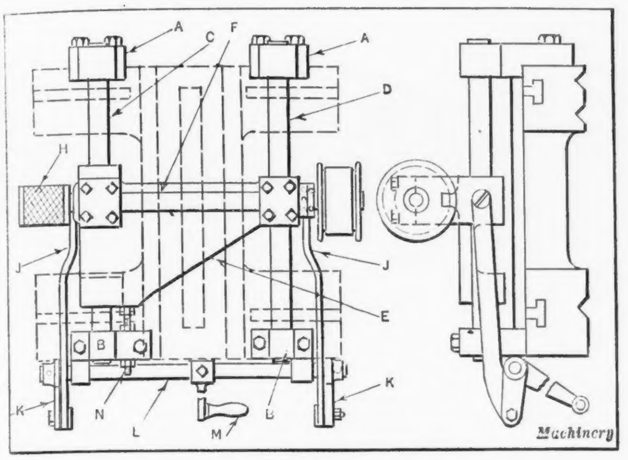
CENTER-DRILLING ATTACHMENT FOR LATHE

When a considerable number of cylindrical pieces require centering on the end, or when it is necessary to center a face opposite a short shaft on an irregular casting, it is common practice to place the work in a lathe chuck and true it up prior to drilling and countersinking the center hole. Usually this class of work necessitates the backing away of the tailstock when inserting or removing the parts from the chuck.

A device that permits speed and accuracy in performing this simple but essential operation is shown in the accompanying illustration. The attachment is fitted to an ordinary engine lathe. On the top of the traverse carriage are mounted the brackets *A* and *B*. These brackets support the two cross-slide shafts *C* and *D*, which are secured in position by pouring babbitt in one of the brackets when the complete fixture is in proper alignment.

The main housing casting *E*, which carries the centering spindle *F*, is fitted with three bearings to maintain alignment of the spindle. This is kept revolving continually, and the center drill and countersink are used alternately by changing them in the small cam-operated chuck *H*. The connecting-rods *J* are attached to the lower portion of the cross-slide and also to the operating shaft *L* by means of the short crank *K*.

By the movement of handle *M*, this toggle arrangement serves to slide the drill spindle out of the working position, thus facilitating the placing of the work in the chuck. The



Center-drilling Attachment for Lathe

positive stop N assures the exact alignment of the spindle when the slide is returned to the working position. By running the drill spindle in the opposite direction to that of the lathe spindle, greater accuracy is assured. In this case, the work may revolve at a speed of 50 revolutions per minute, the small drill at 600 revolutions per minute, and the reamer or countersink, at 350 revolutions per minute.

JAMES R. HENDERSON

KEYSEATER DEPTH-GAGING ATTACHMENT

In the plant where the writer is employed, a large number of gears and similar elements are required to have keyways machined in them. Orders of one and never more than six of a kind constituted this class of work, and for this reason it was considered unprofitable to build special fixtures to hold the various parts. The machine used for cutting the keyways is a standard Baker keyway slotter which handles the work very well.

In order to avoid frequent measuring to insure cutting the keyways to the correct depth, the attachment shown in the illustration was designed and fitted to the table feed-screw which advances the work to the cutter. This attachment saves considerable time and prevents cutting the keyways too deep. The device is made with an index-plate A of machine steel, on the face of which eight lines, spaced 45 degrees apart, are scribed. These graduations are marked in increments of 1/32 inch, although only the zero mark at B and the first graduation at C are shown in the illustration. A 7/16-inch hole is drilled and reamed on each graduated line, and a hole 2 1/8 inches in diameter is bored in the center of the plate.

At D is shown the indexing finger, which was made from a steel forging and machined as shown in the detail view. At E are two clamping nuts which hold the index-plate A in place. The details of the clamping bushings F and G are shown in the upper left-hand corner of the illustration. These bushings are machined to a good sliding fit in the 1-inch reamed hole in finger D. The indexing pin H is made a good slip fit in the evenly spaced holes in plate A. The table feed-screw J of the keyseating machine is 2 1/8 inches in diameter and has four threads per inch. Therefore, one revolution of this screw moves the table ahead 1/4 inch. In attaching the gaging device to the machine, the plate A is first placed on the end of the table feed-screw and fastened by the two lock-nuts E, which are threaded to fit the feed-screw. The dowel K is next driven into place. The end of the table feed-screw is turned down to a diameter of 1 1/4 inches, and on this reduced portion is placed the finger D. The locking bushings F and G are next put in place in finger D and the cap-screw L is tightened. The nuts E not only assist in holding the plate A but also serve as a spacer for the indexing finger.

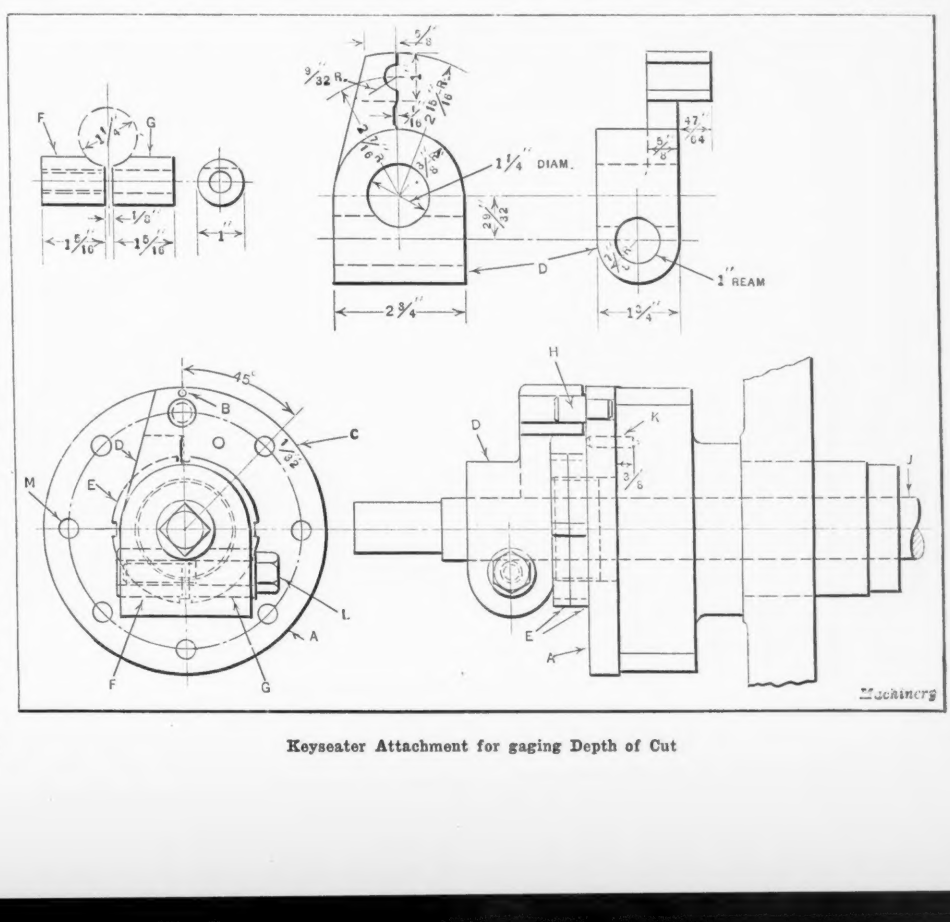
The manner in which the attachment is used is described in the following: The part in which the keyway is to be machined is fastened on the machine table in the usual manner, and the keyway cutter placed in position through the bored hole. The table is then fed back until the edge of the cutter comes in contact with the side of the bored hole in the piece. Let us assume, for instance, that a keyway 3/16 inch deep is to be machined. With the cutter just touching the metal where the keyway is to be cut, the index-finger is slid around until the face coincides with the zero index line, where it is locked by tightening the cap-screw L.

In this case, the operator would next place the index-pin H in the hole M which, on the actual plate used, is marked 3/16 and is the sixth hole from the zero line. The operator then feeds the table toward the cutter in the usual manner until the finger D comes in contact with the indexing pin in hole M. This assures the workman or operator that the keyway is machined to a depth of exactly 3/16 inch, and no measurement is necessary. It is obvious that by the use of this attachment the time required for machining keyways is greatly reduced and the danger of cutting a keyway too deep is eliminated.

Gary, Ind. ROBERT MAWSON

BUILDING A MACHINE WITH HAND TOOLS

Building a machine without the aid of any kind of machine tool is rather an uncommon feat. However, a model adding machine was built in this manner by its inventor, who had only hand tools to work with. The tool equipment employed consisted of a bench vise, a hand drill, saws, files, and a few machinists' tools. First the inventor made drawings of the model and, in order to save as much work as possible, arranged the design so that about 20 per cent of the parts could be purchased ready-made from manufacturers and dealers. Among such parts were gears, ratchets, springs,



Keyseater Attachment for gaging Depth of Cut

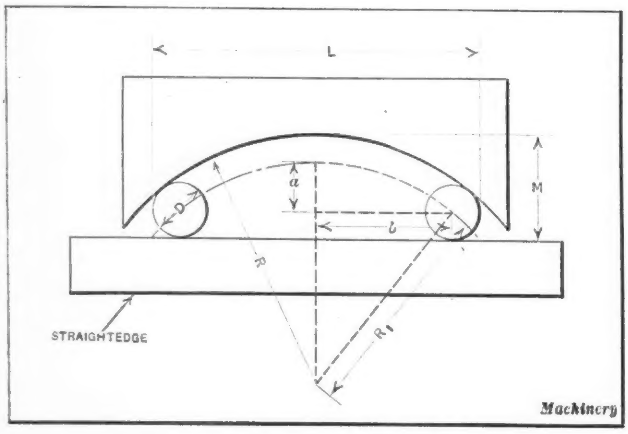


Fig. 1. Diagram used in applying a Formula to determine the Radius of a Large Gage

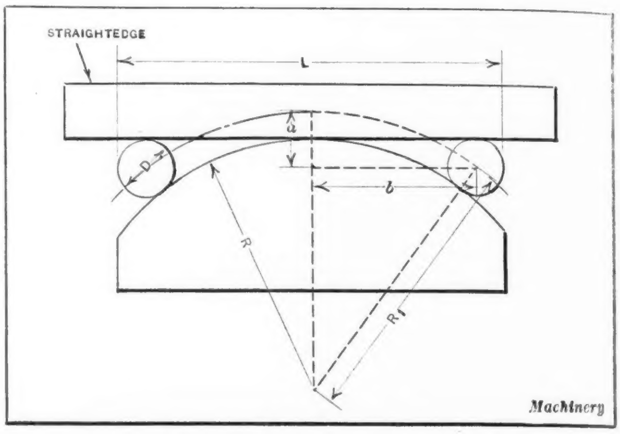


Fig. 2. Second Example solved by Means of the Formula used in Connection with Fig. 1

screws, and nuts. The larger number of parts, however, had to be made by hand, using the tools mentioned.

The sides of the machine were made from two plates cut from cold-rolled steel, 1/8 inch thick. These plates were assembled or connected by three tie-rods. The tie-rods were held in holes in the plates by soldering. The casing, made of 1/32-inch cold-rolled steel, was formed to fit the contour of the side plates and secured to them by screws. This assembly, with a plate fastened to the bottom, formed the complete case which contained the adding machine mechanism. The operating keys and handles extended through openings cut in the casing.

The shafts were made of drill rod, and holes in the side plates served as bearings. Collars and sleeves were made of tubing, and such parts as key levers, cams, and pawls were made of 1/16-inch cold-rolled steel. The outline of these parts was scribed on the sheet steel, after which the parts were cut out with a hacksaw and filed to the required shape. When completed, the model machine operated satisfactorily and presented a neat appearance. The methods employed in making this machine may well be used by designers who desire to make their own models but who do not have the opportunity to use machine tools. It might be of interest to note that the inventor who built the model adding machine referred to was over eighty years of age and built the model as a matter of business and not merely as a pastime.

Pawtucket, R. I. S. W. Brown

INSPECTING LARGE RADIUS GAGES

The writer was much interested in the article "Inspecting Large Radius Gages," published on page 403 of January Machinery, because he too has had to inspect gages of this type on many occasions. However, he uses the following simple formula for both cases given in the article referred to (see Fig. 1):

$$R_1 = \frac{a^2 + b^2}{2a}$$

After determining dimensions L and M of the example shown in Fig. 1 (convenient sized disks can be used for finding dimension M), we find a and b as follows:

$$a = M - D \qquad b = \frac{L - D}{2}$$

where

D = diameter of rods or disks used;
L = dimensions over rods;
M = distance from straightedge to arc.

Then, if R = required radius of gage, and r = 1/2 D,

$$R = R_1 + r \qquad R_1 = \frac{a^2 + b^2}{2a}$$

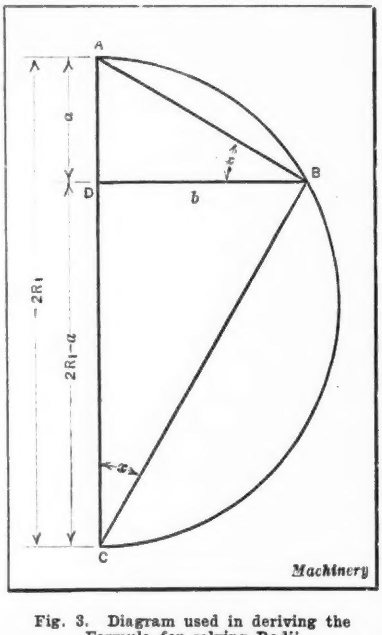


Fig. 3. Diagram used in deriving the Formula for solving Radii

In the second case, shown in Fig. 2, the straightedge is held tangent to the gage and two convenient sized rods or disks D. After determining dimension L, we find $b = \frac{L - D}{2}$ and $a = D$ by inspection.

Again,

$$R_1 = \frac{a^2 + b^2}{2a} \qquad R = R_1 - r$$

It may be of interest to know how the formula for R_1 is derived. As an angle inscribed in a semicircle is a right triangle, ABC in Fig. 3 is a right triangle. A perpendicular drawn from vertex B to D on the hypotenuse will form two similar triangles. Therefore, angles ABD and BCD are similar from which we derive the formula:

$$\frac{2R_1 - a}{b} = \frac{b}{a}$$

$$2aR_1 - a^2 = b^2$$

$$R_1 = \frac{a^2 + b^2}{2a}$$

Philadelphia, Pa. Frederick J. Naab

* * *

ARC WELDING IN STEEL CONSTRUCTION

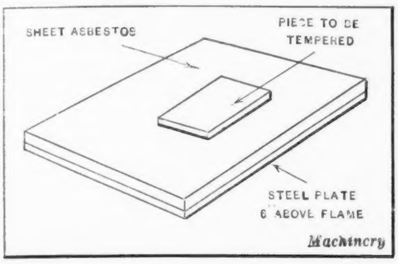
The reticence of construction engineers in the past to make extensive use of welding in place of riveting in building construction is gradually changing. Based upon careful investigations into the characteristics of arc-welded joists, the Massillon Steel Joist Co. of Massillon, Ohio, has placed on the market a welded steel joist designed like a plain Warren truss with cantilever ends. All material used in this truss consists of structural shapes, bars, and end plates. Complete tests were made in Massillon to determine the strength and reliability of the welds, and these tests were highly satisfactory, but the Massillon tests were not accepted as final proof. Outside inspections and tests have also been made by the Pittsburg Testing Laboratory, the University of California, the Ohio State University, the Philadelphia Testing Laboratory, and the Toronto University, Canada. Lincoln arc-welding apparatus was used in making these welds.

These joists were not constructed especially for test purposes, but were picked at random from a large stock of joists, the welds on which had been produced at regular production speed under usual manufacturing conditions. Welding engineers agree that a strong weld requires proper equipment and trained welders, but with these requisites, welds do not suffer by comparison with riveted joints.

Shop and Drafting-room Kinks

TEMPERING HARDENED STEEL PIECES

The writer has found that hardened steel pieces can be easily and more satisfactorily tempered or drawn if placed on a piece of sheet asbestos laid on a steel plate supported about 6 inches above the flame. The arrangement of the plate, asbestos sheet, and work is shown in the illustration. One end of the piece of work can be raised about 1/8 inch from the asbestos to give the other end a chance to draw faster. For small tools, a steel plate 1/8 inch thick and 5 inches wide by 6 inches long is a convenient size. The asbestos sheet should be the same size as the plate and about 1/4 inch thick.

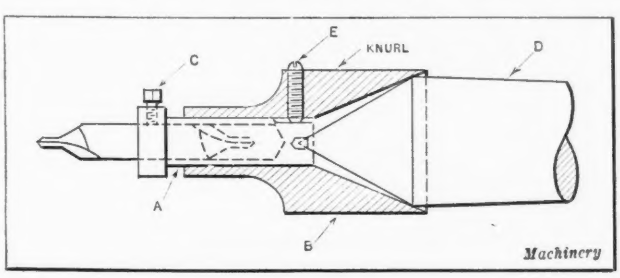


Method of holding Steel Piece while tempering

Philadelphia, Pa. W. H. FLYNN

CENTERING TOOL FOR LATHE

A convenient centering tool for use in the lathe, which consists primarily of two parts, *A* and *B*, is shown in the accompanying illustration. The member *A* is a sliding fit in the part *B*, and is kept from turning by a small set-screw *E*. A regular center reamer drill is held in the member *A* by the set-screw *C*. The tapered portion of the part *B* is machined to an included angle of 46 degrees. A lathe center, having an included angle of 60 degrees, permits the tool to be centered or located by the dead center *D*, as the part *A* is a sliding fit in member *B*. This construction serves to bring the center reamer always in line with the center line of the dead center. In centering a piece of work held on the faceplate or in a collet chuck, the workman simply grasps the centering tool by the knurled portion and places it over the center *D* as shown, holding it in this position while the tool is advanced to drill the center.



Centering Tool for Lathe

Paterson, N. J. S. COURTER

CASEHARDENING CAST IRON

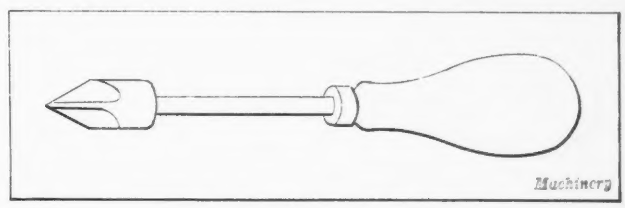
Casehardening, as generally understood, is applied only to steel of a low carbon content, such as machine and cold-rolled steel. Some time ago the writer was confronted with the problem of increasing the wearing qualities of the end of an oscillating cast-iron knock-off arm. The end of the arm was designed to slide over a dog employed on a special machine, and was subjected to considerable pressure which caused the part to wear out quickly.

As it was impossible to attach hardened pieces to the wearing point, the writer made the following experiment, which resulted in lengthening the life of the parts. The arm was placed in such a position that the part subject to wear was immersed in a cyanide bath. After being heated in this bath for twenty minutes, the part was quenched quickly in cold water. This treatment produced a hardened case nearly 1/32 inch deep. The arms treated in this manner gave satisfactory service for from four to six months.

Bridgeport, Conn. J. E. FENNO

BURRING TOOL

In the accompanying illustration is shown a tool for removing burrs from the edge of dowel-pin holes. It can also be used to good advantage in removing burrs from the edge of tapped holes. A few quick twists serve to smooth up the edge of the hole so that the pin or threaded screw, as the case may be, can be easily entered. The tool shown is simply a 60-degree countersink, 1/2 inch in diameter, with a shank of sufficient length to permit the file handle to be secured to it.



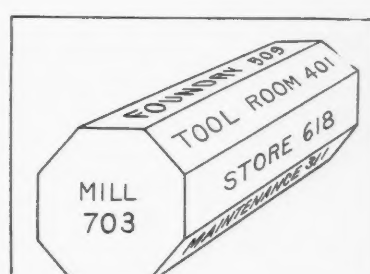
Hand Burring Tool

Galion, Ohio ARTHUR R. MYERS

FIND THE FOREMAN

The absence of shop foremen from their departments is often a source of annoyance to the shop superintendent, manager, or other executive who may be making a trip around the plant. The foreman could, of course, inform someone as to his destination when leaving his department or he could leave a note stating where he can be located. A better method, however, is to use "foreman finders" like the one shown in the illustration.

The "finders" may be easily made by planing down the four corners of a 3-inch square piece of wood stock by running it through the planer. The octagonal-section piece thus obtained is cut up into convenient lengths which are then painted white. The departments or places which the foreman has occasion to visit and their phone numbers may be written on the sides and ends of the pieces. When leaving his department, the foreman simply places the block on his desk or bench with the name of the department or place he is to visit uppermost.



Foreman Finder

Philadelphia, Pa. JOHN F. HARDECKER

* * *

The exports and imports of the United States in 1925 were the greatest since 1920, according to information published by Secretary Hoover. The exports in 1925 were valued at nearly five billion dollars, and the imports at approximately four and one-quarter billion dollars.

Questions and Answers

MACHINING CONNECTING-RODS

R. A.—I would like to obtain the opinion of automobile production men on the best method of finish-machining the crankpin end of connecting-rods, particularly those having a babbitted bearing cast in the rod. The width of the rod must be faced within limits of plus or minus 0.002 inch.

This question is submitted to MACHINERY's readers.

HOW CAN A RIBBON SPIRAL BE MADE?

A. E. M.—Could some one of MACHINERY's readers suggest a method by which a ribbon spiral might be made, 11 3/4 inches outside diameter with a 1/8-inch pitch, using for the purpose 1/8 inch by 1 1/2-inch flat machine steel? Is there some method by which the flat steel could be rolled up into such a spiral? If anyone has done a similar job, information would be appreciated.

MANUFACTURING FLAT FORMED SPRINGS

W. A.—I would appreciate information on the methods used for manufacturing flat formed springs. What kind of spring steel is used, and to what heat-treatment is the steel subjected before or after forming? What equipment is required in the hardening room for hardening flat springs in small quantities? In fact, any information on the successful production of flat formed springs will be appreciated.

SOFT SPOTS IN HARDENED STEEL

F. S.—I have had trouble with soft spots in embossing dies made from water-hardening carbon steel. These dies weigh about 85 pounds and are heated about 2 1/2 hours in a gas furnace. At the end of this time they are covered with a black coating, most of which flakes off or curls up and drops off. In some spots, however, the coating sticks to the surface and under these spots the metal is soft. Would packing these dies in an air-tight box, while heating, prevent this difficulty? What would be the most suitable packing material that would leave the dies clean and still would not affect their carbon content?

SPECIFYING RIVET AND SCREW SIZES

S. M.—In specifying rivet and screw sizes, should the diameter or the length of the rivet or the screw be stated first? For example, if an order was written as follows: "5000, 1/8 by 3/32 rivets," would the diameter be 1/8 or 3/32 inch?

A.—There is no standardized rule for specifying the diameters and lengths of rivets and screws, but in general practice, the diameter is written first. It is, however, preferable to state clearly the meaning of all dimensions in specifications, to avoid misunderstanding. There is no reason why the specification should not be written "5000 rivets, 1/8 inch diameter by 3/32 inch long under head."

MACHINING NON-METALLIC GEARS

A. I.—I would like to obtain some information on the subject of machining non-metallic gears, especially those made from the materials known by the trade names "Micarta" and "Formica."

A.—According to the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., maker of "Micarta," this material, when used for gears, is furnished in a number of forms—plates, blanks cut from plates, and molded blanks. Gear blanks can readily be cut from plate stock either by the use of a band saw or a trepanning tool, as described in the following.

In cutting blanks, a band saw having a 36-inch diameter wheel running at a speed of 350 revolutions per minute is recommended. The saw should be of the bevel-tooth type, seven teeth to the inch.

When a large quantity of gear blanks of identical size is required, a trepanning tool will be found to present the best method. This tool can be used either in a drill press or a boring mill. The "Micarta" plate should be laid out for the size of blank desired, then the holes that are to guide the pilot of the trepanning tool should be drilled. In trepanning blanks, the tool should be fed so as to cut part way through all of the "lay-outs," then the "Micarta" plate should be turned over, and the cutting completed from the reverse side. Full-size working blueprints of the trepanning tool will be furnished on request by the Westinghouse Electric & Mfg. Co.

Turning tools should be of high-speed steel cutting at speeds similar to those used for bronze or cast iron—100 to 125 feet per minute. If two cuts are taken—roughing and finishing—it is not essential that a high-speed tool be used for the first cut. It should, however, be employed for the finishing cut. About 0.010 inch of stock should be left for the finishing cut.

In drilling, attention should be paid to the direction in which the drill is fed with respect to the layers of the material. Drilling at right angles to the layers is done with a standard drill, which should be backed off sufficiently to provide plenty of clearance. When drilling parallel to layers, a "flat" or "bottom" drill should be used at about the same speed; the feed will decrease automatically.

The drill should be lifted from the work frequently to prevent excessive heating and dulling of the tool. However, the drill can be run at speeds slightly in excess of those used in working soft steel. When holes to be drilled are 3/4 inch or over, place the material in a lathe chuck, and with a standard tool-holder use an insertion tool for removing the stock.

In rough-drilling, the hole should preferably be drilled partly through the material from each side to prevent possible splitting as the tool protrudes. If this is deemed impracticable, the hole can be drilled all the way through the material, provided it is "backed up" with wood, stiff cardboard, or any other material that is sufficiently rigid to support the under surface at the point where the drill comes through. Regardless of the method of drilling, the boring tool may be allowed to follow through the hole with no particular precaution. In working blanks that have been trepanned, better results can be obtained by using a counterbore, the pilot hole made for the trepanning tool serving as a guide for the counterbore.

The methods described for drilling apply as well to tapping, except that when the tapping is done parallel to the layers, it is advisable to clamp the material to equalize the stress on the layers and prevent possible splitting. For all threads other than those having a 60-degree angle, standard methods of "set-up" may be used with satisfactory results; the compound rest need not be disturbed. In cutting threads with 60-degree angles, it is advisable to swing the rest on the lathe to a 30-degree angle. The tool used in threading should be ground to cut on one side only. The speeds and feeds are similar to those used in threading soft steel.

In milling any of the grades of "Micarta," a standard tool may be used at a speed and feed corresponding to that used in working bronze or soft steel. The cutting angle of the cutter will give better results if ground with a slight rake.

While there is a wide range of practice as to feeds and speeds in cutting gears on hobbing machines, a hob speed of not less than 140 revolutions per minute, is recommended, and in some instances, excellent results have been obtained at speeds as high as 210 revolutions per minute on hobs from 3 to 4 inches pitch diameter. The feeds that work in unison with these speeds are approximately 0.040 to 0.080 inch with the tendency toward the higher feed.

In machining gear teeth on a gear shaper, a speed of about 100 to 130 strokes per minute is recommended with a fairly fine feed, unless both roughing and finishing cuts are taken, in which case the usual 0.010 inch of stock left for finishing can be removed at any feed and speed desired. In the case of a shaper with a high-speed head, it is advisable to use a stroke in the vicinity of 500 per minute.

In machining gear teeth with rotary cutters, it is advisable to use the highest cone speed with which the machine is equipped, with feed in proportion. The use of backing-up plates in machining "Micarta" gears is recommended. When the teeth are cut with a rotary cutter or with a hob, and the cutter or hob, as the case may be, is kept properly sharpened, backing-up plates are not essential if the machining is done with the proper feed and speed. However, a slight fraying out may occur on that edge of the blank through which the tool makes its final cut. When "Micarta" gears are cut on a gear shaper, a backing-up plate should be used in all cases, to avoid fraying the edges.

Machining Formica

According to information obtained from the Formica Insulation Co., Cincinnati, Ohio, blanks can be cut from sheets either by a band saw or by two trepanning tools attached to a head in a boring mill or a drill press. In sawing blanks, first describe a circle with dividers or by scribing around a metal form, as a guide line; use a 21-gage 3 1/2-point saw running at a speed of 5000 feet per minute, which is equal to 550 revolutions per minute on a 36-inch band saw wheel. The saw should be sharp, with a 1/64-inch set on both sides.

In drilling, use an ordinary high-speed drill whose point is ground to an included angle of 55 to 60 degrees, which is 5 degrees less than the standard for metal. Another method is to grind the drill point slightly off center. If the drills are ground standard, the tendency is for the work to heat up and grip the drill. The feed must be rapid and caution used to prevent the drill from lagging in its work, and the speed must be 1200 revolutions per minute.

For all machine operations on "Formica" gear material, provision must be made in grinding for the tools to clear themselves. For reaming, the entry of the reamer and the reaming process must be rapid. There must be no lag between the end of the reaming operation and the withdrawal of the reamer. In reaming a hole 2 inches in diameter by 1 inch deep, the reamer should make its entry and withdrawal in five seconds.

In turning the outside diameter and sides of blanks, the tools must be sharp and have 3 to 5 degrees more rake than is common practice for metal. A cutting speed of 750 feet per minute, which is equal to 720 revolutions per minute on a 4-inch diameter blank, is recommended. The depth of the cut can be 1/16 to 1/8 inch, as production needs may require, but the feed should be 0.010 inch, regardless of the depth of the cut.

Teeth may be cut on a hobbing machine, shaper, or milling machine. Assuming the cutter or hob to be 3 inches in diameter with 10 teeth, the speed of the cutter should be 150 feet per minute, or 190 revolutions per minute, and the feed from 0.023 to 0.040 inch per revolution.

It is good practice to cut gears (when the design of the hub will permit) in multiple, handling as large a quantity as possible within the limits of capacity of the machine and within the capacity of the holding mandrel to remain rigid. Always back up the last blank to prevent fraying or breaking out of the material as the cutter comes through. The backing plates can be economically made from hard wood. For quantity production, a metal plate, of a design that can be rotated by the operator in relation to the cutter teeth, after the gear blanks have been locked on the arbor and the arbor set in the machine, can be used indefinitely.

* * *

A meeting was held in Cleveland March 12 between representatives of the iron and steel industry and the electrical manufacturers, with a view to starting work on the standardization of mill type electric motors.

CHASERS FOR SELF-OPENING AND ADJUSTABLE DIE-HEADS

The manufacturers of chasers for self-opening and adjustable die-heads have long been burdened with the necessity of producing a part of their output with special and odd thread forms and pitches. This has necessitated the expansion of stock lists beyond the economic limit and far in excess of all normal needs. In order to discover a practicable remedy for this wasteful confusion, the manufacturers recently made a survey of current conditions to determine which items might be eliminated without causing financial loss or disruption of service to anyone concerned. During the early stages of the survey it became apparent that, of the thousands of sizes of chasers that are ordered, less than one hundred represent the essential minimum.

In their planning, the manufacturers were desirous of supporting the work of standardization that has been accomplished by the National Screw Thread Commission, the American Society of Mechanical Engineers, and the American Engineering Standards Committee. With this aim in view, the producers of chasers convened in New York on October 8 and 29, 1925, under the auspices of the American Society of Mechanical Engineers. On both occasions representatives of the Sectional Committee on the Standardization and Unification of Screw Threads, and representatives of the die-head chaser manufacturers concurred in the belief that the cooperative services of the Division of Simplified Practice would be helpful in gaining widespread adherence to the suggested list of stock sizes and pitches for chasers, which had been based on the survey.

The conference was of the opinion that the tentative list of sizes reflected the best thought and practice in the industry and that the list would satisfy more than 80 per cent of all normal requirements. The other 20 per cent of current demand, it was felt, could without difficulty adapt itself to the recommended list during the transitional period which would be allowed for that purpose. The survey further showed that manufacturers have been obliged to carry special items for unreasonably long periods of time, such items often requiring from one to four years for one turnover. The consequent frozen investment becomes apparent when one realizes that a high percentage of orders are for specials.

With the preliminary facts assembled in the form of a tentative schedule, the manufacturers requested the Division of Simplified Practice to call a general conference of manufacturers, distributors, and users, to prepare a final simplified list for the attention and support of all interests. This conference was held in Washington on December 4, and in accordance with the unanimous action of representatives of manufacturers, distributors, and users, the United States Department of Commerce, through the Bureau of Standards, now recommends that the simplified list of sizes and varieties adopted, be established. The complete list may be obtained by addressing the Division of Simplified Practice, Department of Commerce, Washington, D. C.

The final conference resulted in a reduction of 75 per cent in the sizes and varieties of chasers. It is hoped that engineers, purchasing agents, works superintendents, standardization bodies, and all manufacturers, distributors and users who are in any way concerned with die-head chasers will derive such tangible results from this simplified practice that it will become desirable to extend the application of the principles of simplification to other items in the field of mechanics. Such practice should decrease stocks, production costs, selling expenses, and costs to the user.

* * *

What is said to be the largest steam turbine generator ever exported from the United States has just been ordered by the Spanish American Electrical Co. of Buenos Aires. This company has ordered two General Electric 52,500 kilowatt tandem-compound steam turbine generators to be installed in a new generating station to be built at the entrance of the harbor of Buenos Aires.

Influence of Design on Production*

By EARLE BUCKINGHAM, Professor of Engineering Standards, Massachusetts Institute of Technology, Cambridge, Mass.

IN a recent interview, Henry Ford made the statement that the problem of production starts on the drawing-board. Before a pencil is put to paper, one must know what he wants to make. The next step is to find out how to make it, and that is a job that is never finished.

The problem of production has two phases—first, the creation and initial operation of production methods to manufacture a new commodity; and second, the refinement and improvement of production methods on a commodity already in production. Those of us who have had experience in trying to start production on a new model will recall the many changes in method of greater or less extent that were required, the changes in design of the product, hurried provision for makeshift facilities to perform some operation that had been overlooked, and the almost endless petty problems that constantly arose to delay progress. It is a common experience to have it take from several months to a couple of years for the production of a new product to really function smoothly. The reason for this is that we did not start back far enough in our drafting-board work. The real starting point for efficient production is in the design of the product itself.

Those who have had experience in starting production on a new mechanism know that many changes in production methods and in the design of the product are required before satisfactory and efficient methods are finally established. Frequently, makeshift facilities have to be adopted to perform some operation that has been overlooked. It is common experience that from several months to a couple of years are required before the production methods for a new product really function smoothly. The reason for this is, generally, that the planning for production does not start back far enough—way back in the drafting-room. The real starting point for efficient production is in the design of the product itself.

Steps by which a New Mechanism is Developed

The development of any new mechanism starts with a mental conception of some function to be performed. This conception then takes detailed form, first mentally, then on paper, and finally in metal. The first or experimental model is usually made by the cut-and-try method. Changes from the original design are almost inevitable before such a new mechanism will operate with full satisfaction. Little attention is paid at this time to future manufacturing requirements. The main object is to make this mechanism perform properly, regardless of the exact design. When this end is reached, what may be called the inventive or functional design has demonstrated its success.

But we are not yet ready to go into production. To do so would involve a large amount of experimental work on a production basis. Before manufacturing is begun, what may be called a production or manufacturing design should be perfected, which will modify the inventive design where necessary, so as to allow its economical production on a large scale. Many manufacturing organizations recognize this two-fold nature of designing, and maintain a separate department for each type. Indispensable as is the original invention, it is the manufacturing design which largely determines the expense or economy of production of a given commodity, and thus directly affects its commercial success or failure.

Designing a Product to Suit the Equipment Available

The manufacturing design has several purposes to fulfill. In the first place, it must be such that all necessary production operations can be performed readily with the manufacturing equipment that is available. Here we have two possible conditions to meet. First, if the commodity is to be produced in a new plant for which manufacturing equipment is to be provided as required, there are few, if any, restrictions placed on the choice of the processes to be employed in production. Second, if it is to be made in an existing plant, the choice of processes to be employed is limited to a great extent by the manufacturing equipment available. In either case, the details of the manufacturing design should be controlled largely by the production methods to be employed. This requires that the manufacturing designing be done in close cooperation with the production department when the selection of manufacturing processes is being made. Often a minor change in the size or shape of some part of the product makes possible a material saving in the cost of production.

Simplifying the Design and Eliminating Extreme Requirements for Accuracy

Another and a primary object of the manufacturing design should be to simplify the construction of the proposed products as much as possible. Simplicity is always a source of economy. This holds true for both the product itself and the manufacturing processes. No design or process can be considered as finished until it meets the test of simplicity.

Another important function of the manufacturing design is to so arrange the mechanism that it requires a high order of accuracy on as few surfaces as possible. A little study will show that in almost every mechanism there are a few critical and essential surfaces and inter-relations, but that the great majority of them are relatively unimportant. Take a watch, for example. The essential part of a watch is the escapement mechanism. If this be good, the watch will keep good time. But the escapement is only a small part of the watch. Furthermore, in the escapement itself there are some relatively unimportant details. The remainder of the mechanism of a watch is a train of gears with a spring to drive them. The requirements for this larger part of the mechanism are not nearly so severe as those for the escapement. Thus the manufacturing design should always strive to keep severe requirements to a minimum.

As Liberal Clearances as Possible Should be Provided

Still another important function of the manufacturing design, which is closely allied to the preceding one, is the development of a design that will permit liberal clearances. Clearances should be one of the principal considerations in developing the production design. This should aim to allow the greatest possible amount of clearance between companion parts. The more the design lends itself to this end, the greater the variation or tolerances that can be permitted, and hence the greater the economy of production; also, the greater the degree of interchangeability of parts.

Clearances are vital factors in interchangeable manufacturing. Fits can be secured without interchangeability, but the latter cannot be maintained without proper clearances. It is self-evident that a certain space must be left between operating parts. The minimum clearances should be as small as the assembling of the parts and their proper operation under service conditions will allow. The maximum clear-

*Abstract of a paper to be read before the Providence Meeting of the American Society of Mechanical Engineers, May 3 to 6.

ances should be as great as the functioning of the mechanism permits. Every operating part of a mechanism must be located within reasonably close clearances in each plane. After such requirements of location are met, all other surfaces should have liberal clearances.

Do Not Give Undue Importance to Non-essentials

An important consideration in establishing the manufacturing requirements of any commodity should be to determine and define the few essential requirements first, and let the non-essentials take care of themselves later. Full economy in manufacture requires that due care and pains be taken where necessary, but that all unnecessary refinements be omitted. The essential requirements need and should be given the greatest attention. This, however, is seldom done. All machined surfaces on all parts are often considered of equal importance. The result of such a practice is that the essential points do not receive the attention they need, while the non-essentials receive more than they require; as a consequence, a product of inferior quality is produced at a higher cost than a superior product would cost if attention were concentrated upon the most important points.

Good Design Permits Units to be Made and Assembled Independently

Another object of the manufacturing design should be to so arrange the mechanism that as many units as possible can be made independently. Almost every mechanism can be subdivided into smaller units which are distinct in their purpose. For example, an automobile contains an engine, transmission, axle drive, carburetor, magneto, etc., which are first assembled and tested as units, and later assembled into the completed car. In like manner, a typewriter is subdivided into the carriage, escapement, type bar, and segment unit, etc. Both the assembling and final testing of the completed product are greatly facilitated if the design permits such unit-assembly construction; and efforts should be made to obtain this result whenever possible.

There are many other advantages of the unit-assembly construction. Not only the various manufacturing departments of one factory, but also entire plants are specializing more and more. Where such unit assemblies are of equal value on several parts, separate plants are created to produce them as specialties. This, in turn, makes possible quantity production where otherwise it might not be possible, and hence decreases the cost.

In establishing the manufacturing requirements and methods to be used in producing any commodity, it is necessary to determine and define a few essential requirements first, and let the non-essentials take care of themselves later. The greatest economy in manufacturing requires that care be taken wherever necessary, but that all unnecessary refinements be omitted. This is a fact frequently overlooked. Instead, all machined surfaces on all parts are often considered of equal importance. The result is that the essential points do not receive adequate attention, while the non-essentials receive more thought and care than they require, and hence, a product of inferior quality is manufactured at a higher cost.

Standardization Should be Part of Efficient Designing

Another object of the manufacturing design should be to standardize the sizes and shapes of as many machined surfaces as possible, and reduce their variety to a minimum. This practice has a very direct influence on the economy of production. In addition, as many of the smaller parts as possible, such as screws, studs, pins, etc., should be standardized as complete units, keeping the variety of similar parts to a minimum. A good illustration of the economy of this practice is found in the experience of one plant which originally manufactured over one hundred and fifty special screws and studs for its particular product; but little effort was required to reduce this number to less than half. In all of this shop standardization, an effort should be made to use as many of the general engineering standards as possible. In many cases, these general standards are produced as a specialty by some plants, so that they can be purchased cheaper than they can be made in small quantities. In other cases, standard tools for producing the generally standardized surfaces can be secured from stock at a lower cost than for special ones. Standardization is thus another source of economy in production.

Accuracy in the Detail Drawings is of Great Importance

Thus far we have been considering some of the essential features of the production design. We will now direct our attention to features of the drawings themselves. Of these, the detailed component drawings are the most important. The main object of component or detail drawings is to furnish the production departments with the information they need in order to manufacture the product. The present trend of manufacturing is toward specialization. In many cases, the machine operator does not have the slightest idea of the use to which his handiwork will be put. This makes it necessary to have these component drawings as detailed and complete as it is possible to make them. If careful thought is given to these drawings, much time and effort will be saved in the shop. A large percentage of the mistakes made in the manufacturing department may be traced back to improper component drawings.

Kind of Information that is Required on Drawings

It should be evident that the nature of the information required on a drawing depends upon the conditions of manufacturing that exist in the shop. Thus the information that may be sufficient for a general machine shop or tool-room will not be suitable for continuous production. Many minor details can be omitted in the first case—details which are essential in the second. Also the manner of expressing the information depends upon the use to which it will be put. In the tool-room, the drawing itself is the only source of reference; in the production shop, special gages are provided to control the sizes of the product, so that in some cases these component drawings are never sent into the production departments. We will consider now only that type of component drawing required for continuous production.

The first purpose of such drawings is to serve as a guide in the selection and design of the necessary manufacturing equipment. In order to accomplish this, the information on the drawings must be clear, consistent, and complete. The art of expressing information by means of drawings is still in the process of evolution. The introduction of tolerances on component drawings has created new problems which have not as yet been fully solved.

Expressing Tolerances on Drawings

The first tendency in introducing tolerances on component drawings seems to be to attempt to express a permissible variation on every dimension given. The results obtained in production under such circumstances depend, then, upon the particular combination of dimensions used. Variations are inevitable in the physical sizes of a product. Any dimension given on a component drawing without a tolerance should never be construed to denote an absolute size without error, but rather to indicate that either the permissible variation for that point or surface is controlled by tolerances given on other co-related dimensions, or that a specific tolerance for that dimension has not yet been established.

In making component drawings, the effort should be made to so give the dimensions and necessary tolerances that it would be possible to lay out one, and only one, representation of the "maximum metal" condition, and one, and only one, representation of the "minimum metal" condition. If such lay-outs were superimposed, the difference between them would represent the permissible variation on every surface. If a few such lay-outs are made, it will soon be clear that

there are always a number of dimensions that should be given without tolerances if the drawings are to be kept consistent and intelligible.

Rules for Dimensioning Drawings

The problem of the proper dimensioning of component drawings is simple in principle, but often difficult in practice. Adherence to the following laws of dimensioning will avoid many troubles:

1. There is but one dimension in the same straight line that can be controlled within fixed tolerances; that is the distance between the cutting surface of the tool and the locating or registering surface of the part being machined. Therefore it is incorrect to locate any point or surface with tolerances from more than one point in the same straight line.

2. Every part of a mechanism must be located in each plane. Every operating part must be located with suitable operating allowances. After such requirements of location are met, all other surfaces should have liberal clearances.

3. Dimensions should be given between those points or surfaces which it is essential to hold in a specific relation to each other. This applies particularly to those surfaces that control the location of other component parts. Many dimensions are relatively unimportant in this respect. It is good practice in such cases to establish a common locating point in each plane and give, as far as possible, all such dimensions from these common locating points. The locating points on the drawing, the locating or registering points used for machining the surfaces, and the locating points for measuring, or gaging, should all be identical.

4. The initial dimensions placed on component drawings should be the exact dimensions that would be used if it were possible to work without tolerances. Tolerances should be given in that direction in which variations will cause the least harm. When a variation in either direction is equally dangerous, the tolerances should be of equal amount in both directions.

5. The initial clearance, or allowance, between operating parts should be as small as the operation of the mechanism will permit. The maximum clearance should be as great as the functioning of the mechanism will permit.

6. Dimensions should not be duplicated between the same points. The duplication of dimensions causes much needless trouble, due to changes being made in one place and not in the others. It causes less trouble to search for dimensions than it does to have them duplicated and inconsistent.

7. As far as possible, the dimensions on companion parts should be given from the same relative locations. This helps to detect interferences and other improper conditions.

The main object of detail drawings is to furnish the shop with the information needed to manufacture a product. In many cases, the machine operator does not know or understand the use to which the part on which he is working is to be put. This makes it necessary to have the drawings as detailed and complete as it is possible to make them. If careful thought is given to the detail drawings, much time and effort will be saved in the shop. A large percentage of the mistakes made in the manufacturing departments may be traced back to improperly made or dimensioned detail drawings. The time spent in preparing accurate and complete drawings will undoubtedly prove a worthwhile investment.

Other Specifications Required on Drawings

In addition to definite physical sizes, there are often conditions of straightness, alignment, etc., that must be specified. A good general principle to follow in such cases is to express, if possible, these conditions in terms of the methods that are to be employed to measure them. Furthermore, the method used to measure such a condition should duplicate as closely as possible the functional or assembly requirements that it must meet. For example, if it were required to indicate the straightness of a long bolt, this could be done by specifying that the bolt must drop of its own weight into a hole of the same size and length as the hole in which it is to be assembled.

All of the foregoing detail is an essential part of the manufacturing design. When the necessary information about the product is given clearly, consistently, and completely, the problem of the selection of suitable production methods is very much simplified.

Operation Lists and Time Estimates

The first step toward the selection of manufacturing processes is to make up a detailed operation list for each part. The next step is to make an estimate of the time required to perform each operation. This estimate serves two purposes. First, it enables an estimate to be made of the probable cost of production of a new product; and second, it enables the amount of equipment required for any given rate of production to be determined.

Main Points in Jig and Fixture Design

After the machines and methods to be employed have been selected, the next step toward production is the design of the special tools, jigs, and fixtures required for each individual manufacturing operation. There are a number of general principles that apply equally to all types of fixtures.

First, the locating points on fixtures or registering points for tools for all finishing cuts should be identical to those surfaces from which the dimensions are given on the component drawings. On roughing cuts, these locating points are of less importance, yet it is good practice to maintain, as far as possible, the same register points on both roughing and finishing cuts.

The second important factor in the design of fixtures is their operation in service. The use of the proper locating points controls in large measure the uniformity of the product. The facility with which these fixtures may be operated determines to a great extent the rate of production. Thus the direct labor cost of production is greatly reduced with quick-acting jigs and fixtures.

The position of a fixture, when opened, should be in such a relation to the cutting tools that there is no danger to the operator. Whenever the operator is required to put his hands dangerously close to the cutting tools, he normally moves more slowly and cautiously, thus reducing the rate of production. All sharp corners and edges on these fixtures should be eliminated to prevent injury to the operator. The locating points should be accessible to facilitate cleaning and the proper insertion of the work. Liberal chip clearances should be provided to facilitate cleaning the fixture. Whenever possible, the pressure of the cutting tools should be withstood by a solid part of the fixture, and not by a clamp. Fixtures, which are permanently fastened to the machine, should be sufficiently rugged to withstand all use and abuse. Jigs, which must be moved, lifted, or turned over in operation, should be as light as they can safely be made.

Refinement and Improvement of Production Methods

We come now to the second phase of production problems —the refinement and improvement of production methods on a commodity already in production. The development of methods for manufacturing new products will only be met occasionally; the problem of refining and improving existing methods is always with us. In addition to this, in the course of time new demands are made on different classes of commodities. Furthermore, as time goes on, new manufacturing processes are developed. In some cases, these new processes can be used without any change in the design of the product. In other cases, considerable redesigning of the product is necessary in order to obtain the full benefits of the new process. Thus the design of the product and production methods must always be studied concurrently.

New Production Methods and their Study

An interesting example of a new manufacturing process is the development of cold-pressing or coining in a press for steel forgings, to take the place of milling. This process was developed in one of the large automobile plants, and is being adopted very rapidly. It enables the surfaces to be finished in from one-half to one-quarter the time formerly required by milling. Other cold metal-working processes, such as swaging, for example, are receiving considerable attention.

One word of caution, however, should be given in regard to changes in production processes. All such changes do not prove to be improvements. Even greater consideration should be given to a proposed change in process than is given to the original one, because such a change, if made for purposes of economy, must not only pay for the cost of all new equipment required to employ it, but also for the intangible cost of the attendant disorganization to production that always is present when the established routine is disturbed. On the other hand, if an existing process proves to be unsatisfactory, this matter of economy is of secondary importance. But before any great expense is entailed, the design of the product itself should be carefully checked to make certain that the fault is in the process rather than in the design. In many cases, it is the design that is at fault. Under such circumstances, until the design has been corrected, the chances of finding a satisfactory production method are very slim.

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PROVIDENCE MEETING OF A. S. M. E.

At the meeting of the American Society of Mechanical Engineers to be held in Providence, R. I., May 3 to 6, papers of interest to a broad group of manufacturers and engineers will be presented. In the upbuilding of the industries of Providence, the careful training of mechanics through apprenticeships has played an important part. The influence of Providence-trained mechanics, who have gone elsewhere and left an imprint on the industrial development of the country in many fields, is generally recognized. For this reason, the papers to be presented at the session on industrial education, Monday afternoon, May 3, will have a strong appeal. W. A. Viall of the Brown & Sharpe Mfg. Co., will speak on "Has the Need for Apprenticeship Passed?" Frank Cushman will speak on "Training for Foremanship." Tuesday morning, May 4, at the machine shop practice session, Earle Buckingham, formerly engineer with the Pratt & Whitney Co. and now a member of the faculty of the Massachusetts Institute of Technology, will speak on "The Influence of Design on Production." A. C. Danekind will speak on "The Development of Tap-drill Sizes," and J. K. Wood on "Specification and Control of Mechanical Springs." Simultaneously with the machine shop practice session, Tuesday morning, sessions will be held on industrial power and on problems of the wood industries. In the afternoon, excursions will be made to various plants, including the Brown & Sharpe Mfg. Co. The papers by Mr. Viall and Mr. Buckingham are abstracted on pages 692 and 740, respectively.

Wednesday morning, May 5, there will be another machine shop practice session. The subjects to be dealt with are "New England Conditions Affecting the Machine Tool Industries," by E. C. Mayo; "Rotary Swaging," by J. H. Connolly; and "Cold-drawn Steel," by F. W. Krebs. There will also be sessions on central power station work and textile manufacture.

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Announcement has been made of a permanent exhibit to be maintained by the General Motors Corporation at Atlantic City, containing all the products of the various plants of the General Motors Corporation under one roof. The exhibit will occupy 22,000 square feet of floor space on the Steel Pier, and will be formally opened some time in July. In addition to the automobiles and trucks built by the General Motors Corporation, all the products manufactured by the various plants, located in thirty-seven cities in the United States and Canada, will be on exhibition.

SUPPLY AND MACHINERY DISTRIBUTORS' ASSOCIATION MEETING

The twenty-first annual convention of the National Supply and Machinery Distributors' Association was held at the Ambassador Hotel, Atlantic City, N. J., April 26 to 28. On the first meeting day, after opening remarks by the president of the association, B. H. Ackles, of the T. B. Rayl Co., Detroit, Mich., whose address covered subjects of great importance to the field served by the members, a general discussion was opened on the subject "The Business Outlook as it relates to the Mill Supply Industry." Later at the same session, a paper was presented by E. B. Gallaher, president of the Clover Mfg. Co., Norwalk, Conn., on "When Does the Manufacturer Become a Direct Competitor of the Distributor?"

At other sessions during the convention, addresses were made on the following subjects: "Efficient Cooperation Between the Distributor and the Purchasing Agent," by W. L. Chandler, secretary of the National Association of Purchasing Agents, New York City; "Why We Sell Exclusively Through Distributors," by C. D. Garretson, president of the Electric Hose & Rubber Co., Wilmington, Del.; "The Desirability of Trusting the Business Press," by Clay C. Cooper, *Mill Supplies*, Chicago, Ill.; "The Remedy for Price Cutting," by Felix H. Levy, former special counsel to the Department of Justice, New York City; "Inconsistencies in the Supply Trade," by H. G. Elfborg, president of the H. Channon Co., Chicago, Ill.; "The Work Being Done Under the Direction of Secretary Hoover by the Division of Simplified Practice," by R. M. Hudson, chief of the Division of Simplified Practice, Department of Commerce, Washington, D. C.; "Direct versus Dealer Distribution," by Victor Wilmot, Dodge Mfg. Corporation, Mishawaka, Ind.; and "Net versus List Prices," by Fred S. Durham, Bonney Forge & Tool Co., Allentown, Pa.

A report was presented by the special committee on resale price legislation, of which George Puchta, Queen City Supply Co., Cincinnati, Ohio, is chairman. The main social event of the convention was a banquet held Monday evening, April 26, at which G. A. O'Reilly, vice-president of the Irving Bank-Columbia Trust Co., New York City, was one of the principal speakers.

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MEETING OF FOREMEN'S ASSOCIATION

The third annual convention of the National Association of Foremen will be held in Springfield, Ohio, Tuesday, May 25. A whole-day meeting has been arranged for, and foremen from any industry are invited to attend. The program consists of four addresses regarding the foreman's job from the point of view of the industry as a whole, the management, the workman, and the foreman himself. Among the speakers will be Whiting Williams of Cleveland, Cyrus McCormick of the International Harvester Co., Chicago, Ill., and Dr. Harry Myers of Dayton, Ohio. Several factory visits are scheduled for the afternoon. A dinner will be arranged for in the evening, at which it is expected that C. F. Kettering, vice-president of the General Motors Corporation will be the speaker. T. B. Fordham, works manager of the Delco-Light Co., is president of the National Association of Foremen and will preside at the convention. Further information may be obtained from E. F. Myers, superintendent of the French-Hecht Co., Springfield, Ohio.

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In 1914, the ten largest producers of automobiles built 84 per cent of the total number of cars. In 1925, the ten largest producers built 87.5 per cent of the total number. While, therefore, it is true that in the case of the ten largest producers there has not been an appreciably greater concentration of the industry, it must be remembered that in 1914 there were upward of 200 builders of passenger automobiles, and now there are only about fifty. The ten builders that in 1925 were included among the largest producers of cars are: Buick, Chevrolet, Chrysler, Dodge, Durant-Star, Ford, Hudson-Essex, Nash, Studebaker, and Willys-Overland.

The Machine-building Industries

THE three basic industries that determine to a large extent the business activity in most other fields are the iron and steel industry, the automobile industry, and the building industry. When these major industries are active, the freight traffic of the railroads is also at a high level and the prosperity of the railroads is assured.

At present, a remarkable activity may be recorded in all three of the industries mentioned. The United States Steel Corporation, at the middle of April, was operating at as nearly 100 per cent of capacity as is possible in this industry. Ten additional blast furnaces were blown in during March, the number in operation on April 1 being 236. The unfilled orders on the books of the steel companies remain small, because the record-breaking production and the ability of the railroads to handle shipments promptly, permit a continuation of the hand-to-mouth method of buying and immediate shipments. The pig iron output in March was the largest in twelve months. The output of steel in March marked a new record for that month, and the output during the first three months was also a record for that period of the year.

In the automobile field, the same high level of production is being maintained. The March production reached 447,185 cars and trucks, according to the National Automobile Chamber of Commerce. This is the highest output for the month of March ever recorded, and has been exceeded by only one other month in the history of the automobile industry—October, 1925. Record-breaking sales are reported by several companies in April.

In the building industry, a similar condition exists. According to figures published in *Commerce and Finance*, the building permits for the first three months of the year reached approximately $1,500,000,000, as compared with $1,240,000,000 during the same period in 1925. In the field of large construction work, like public works and industrial and commercial buildings, there has been an increase of over 12 per cent, as compared with the same period in 1925. Commenting on these figures, *Commerce and Finance* states that there are weighty reasons for believing that the building industry as a whole, has still a long period of activity ahead, and that those who look for a decline in building activity still look in vain.

The monthly review of the Federal Reserve Bank bears out the impressions gained from a survey of the three major industries referred to. This review records improvement in the textile industry, as well as continued activity in the metal-working industries; employment and earnings of factory workers have increased. Freight car loadings continue at the same high rate as during the past two months, and general business appears to continue at approximately as high a level as in any recent month. On the whole, therefore, business activities in almost every field are considered satisfactory; in fact, in some fields they have been so great that a slight recession must be expected, and even with such a recession, the volume of business must be considered normal.

The Machine Tool Industry

In the machine tool field there was a slight falling off in orders from the previous months during January and February, but in March the new business booked showed a material advance over the average for the first three months of the year. Commenting upon this, Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, states: "Business can never keep a steadily rising trend, but will always be bound to fluctuate more or less from the trend —now above and now below—and when these fluctuations are small they are not at all disturbing to the clear thinker. It is only the ill-informed and too optimistic who believe that business can continuously keep on a steady upward grade.

"Various signs seem to indicate very clearly that there is a perfectly natural recession going on, but the signs also indicate that this recession will not reach the proportions of a serious depression. Business men seem to be judging conditions better and better as time goes on, because business waves seem to be shortening in length, and what is more encouraging, are fluctuating much less. Of course, the machine tool industry, due to causes that it cannot control, feels these fluctuations more than other industries do."

The small tool industry has passed through a period of unusual activity. Several manufacturers of small tools state that March brought a bigger volume of business than any month since the war. This condition was to be expected in view of the great activity in the automotive field, as well as in several other machine-building industries. In the screw products field, there has also been unusual activity, and most of the manufacturers of screw products are operating to capacity.

The Iron and Steel Industry

In addition to the facts given regarding the iron and steel industry in a preceding paragraph, it is of interest to record what the Federal Reserve Bank of Cleveland has to say about the conditions in this field: "A new cycle of increased consumption is apparently being entered upon in the iron and steel industry. After having operated in January and February at a higher rate than in the corresponding months of 1925, which was the year of greatest steel production in history, the industry now is finding itself obliged to spread out production further to meet the current demand. Inasmuch as the mills at present are tied to their customers in a remarkably close way due to efficient transportation, present demands constitute a peculiarly accurate gage of current consumption. Current operations are around 90 per cent of rated steel capacity.

"The present situation is in contrast with that which prevailed at this time in 1925. After heavy production in January and February, demand began to contract appreciably toward the end of March. It had shrunk 10 to 15 per cent within thirty days thereafter. Heavier demands at this time are attributable to a number of factors. The automobile industry is swinging into high production more quickly than a year ago."

The Automobile Industry

Alfred P. Sloan, Jr., president of the General Motors Corporation, commenting upon the current state of the automobile industry, as indicated by the experience of that company, states that March retail sales were 50 per cent greater than a year ago, reaching 106,051 and establishing a new high record in the history of the company. The importance of this figure lies in the fact that March in the past has not recorded as heavy sales as April. Nevertheless, March was the largest month in retail sales ever experienced by the General Motors Corporation. It is further mentioned that there was no excess of unsold cars in the hands of dealers at the end of March, and that some of the cars built by the corporation will lose sales on account of insufficient stocks and inability to bring up production to meet present demand. An interesting feature in this connection is that closed car sales now exceed 80 per cent of the total sales of this company's output. Similar sales records are reported by several other companies in the field.

There are, of course, many who feel that the record of the industry for the first four months of the year has been too spectacular to last throughout 1926, and that there will have to be a compensating slowing down later. This is doubtless true, but all indications point to a production of at least 4,000,000 cars in 1926.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

GISHOLT TURRET LATHES

To meet the demands of present-day production for greater power and increased ease of operation, a new line of heavy ball-bearing turret lathes has been placed on the market by the Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis. Two sizes of these machines are now in production—the 3L having a 21-inch swing and 4 1/2- and 5-inch bar capacity, and the 4L, having a 28-inch swing and either a 9-, 10-, or 12-inch bar capacity. Two types are available in each size—one with a fixed-center turret as illustrated in Fig. 1, and the other with a cross-feeding turret, as shown in Fig. 2. Both types are equipped with a full-swing side carriage having a square turret toolpost.

Each model is adapted to the general range of production work, and the cross-feeding turret is especially useful for small-lot production, railroad, tool-room, and die work, as it permits the use of simple tooling and quick set-ups. Short, stiff tool-holders with forged tools may be used for facing and boring in place of the facing heads and double-end boring cutters required where the cross-feeding feature is not available.

Features of the general design include ball bearings on all shafts transmitting power, and ball thrust bearings for the main spindle and feed nuts; a multiple-disk friction clutch and brake; independent feeds to each carriage; a unit assembly of feed mechanisms; a rapid traverse for each carriage, independent of the feeds; automatic feed and traverse trips; micrometer dials with observation stops; a double bevel turret clamp-ring and index bolt operated by one lever; bronze bearing boxes for the spindle, which are tapered in the housing to permit adjustment and are adjustable from the outside; and a hinged motor mounting.

A heavy cast-iron pan serves as a sub-base or foundation to support the machine. This pan has a series of chambers formed by ribs running transversely and lengthwise. The chambers next to the edge of the pan are covered with heavy perforated steel sheets, which are secured by countersunk screws to furnish a smooth flat surface. Bosses project from the bottom of each chamber at frequent intervals to support the sheets. Cutting lubricant falling on the sheets from the tools is strained and drained back through the chambers to the central reservoir.

The bed of the machine is of heavy box section; it is ribbed laterally every 12 inches and has a center rib extending up under the headstock. The ways are wide and flat, both at the front and back, with an under-cut way low on the front side for supporting the apron of the side carriage. The walls of the headstock have been carried well up above the spindle bearings, and a plate on top presents a flat surface to receive the motor base, which is hinged so that it may be swung back to give access to the headstock without removing the motor. On the 3L machine, the drive from the motor is through a 5-inch belt to a single 18-inch pulley. A motor of 15 horsepower, running at 1200 revolutions per minute, is recommended. The drive pulley rotates at 500 revolutions per minute, is provided with an outboard ball bearing, and is enclosed for safety. On the 4L machine the drive is through a 10-inch belt to an 18-inch single pulley rotating at 450 revolutions per minute, and on this machine the motor pulley, as well as the drive pulley, is provided with an outboard ball bearing located in the surrounding housing. A 25-horsepower motor running at 1200 revolutions per minute is recommended for this machine.

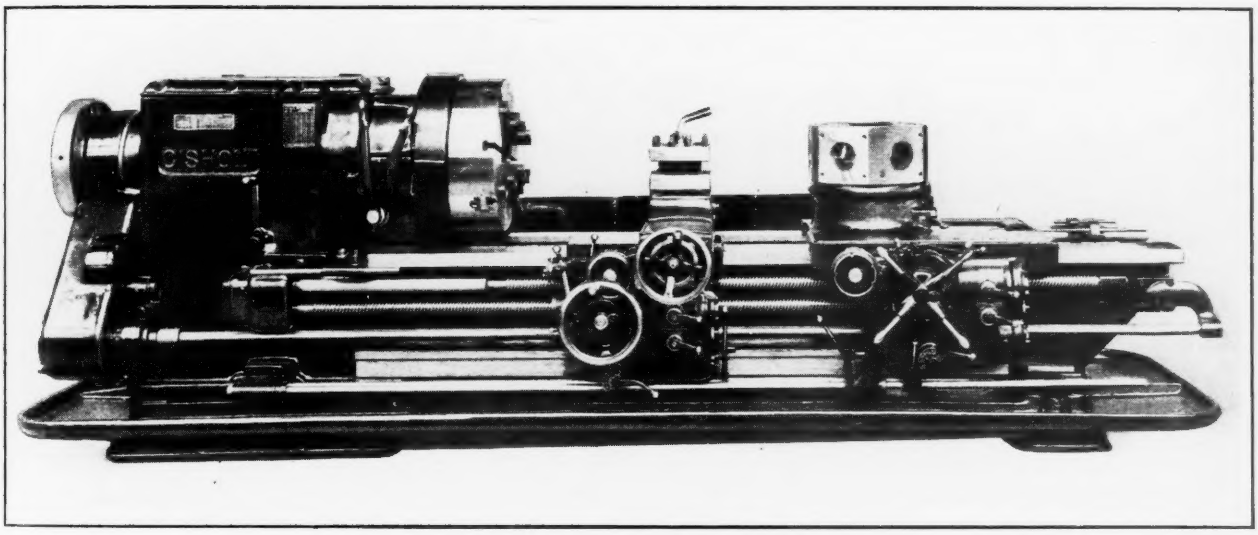


Fig. 1. Gisholt 4L Turret Lathe equipped with a Fixed-center Turret

The headstock comprises a drive shaft carrying a double multiple-disk friction clutch and a multiple-disk brake, an intermediate shaft with the necessary gearing, and a spindle which carries two driving gears. Fig. 3 shows the internal construction of the headstock. Both the drive shaft and the intermediate shaft are carried in annular ball bearings, and the spindle is held in bronze sleeve bearings. Collars used for adjusting the tapered spindle bearings have gear teeth cut on their periphery, and a wrench used for turning these collars carries a gear segment on one end to mesh with these teeth. The segment has a hole in the center which is slipped over a sliding pin in a boss on the front of the headstock. This pin acts as a fulcrum in adjusting the bearing for high-speed work or heavy cuts. Adjustments are made from the front of the machine without raising the headstock cover. The spindle thrust is taken by a large ball bearing located in back of the chuck gear. Altogether, there are sixty-three ball bearings in each machine.

The multiple-disk friction clutch on the back shaft is double, and is thrown to either side when starting, depending on the speed desired. It stands neutral when the multiple-disk brake is engaged. Both the clutch and brake are

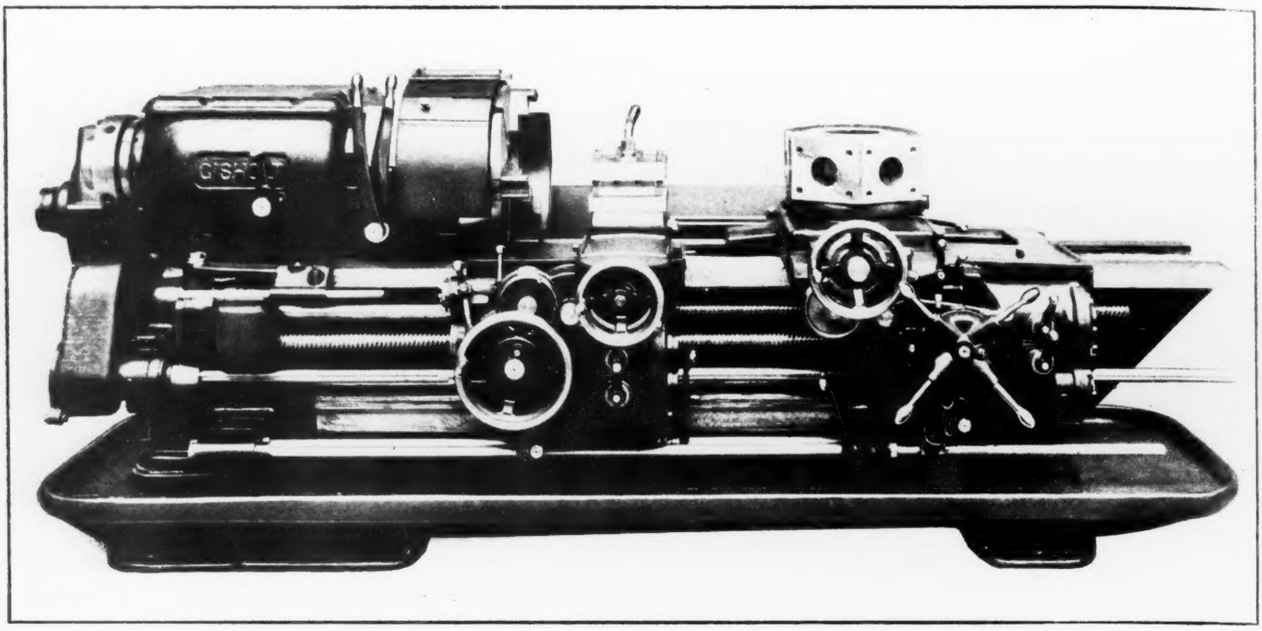


Fig. 2. Turret Lathe of the 3L Size equipped with a Cross-feeding Turret

made of alternate disks of soft steel and phosphor-bronze. Eight speed changes ranging in geometric progression from 8 to 257 revolutions per minute are available for the spindle. The chuck gear is keyed to the spindle flange, while the spindle itself has a threaded nose to receive various types of chucks and fixtures. There is a taper in back of the thread for centralizing the fixtures and chucks and giving a metal-to-metal fit.

A separate lead-screw is provided for each carriage, which revolves only when driven by the rapid traverse mechanism. When the carriage is being fed, the lead-screw stands still, and the feed-shaft, through a ball-bearing gear train in the apron, rotates the nut about the lead-screw. When the rapid traverse is engaged, the lead-screw runs ahead of, or in the opposite direction to, the feed. The latter is still operative at the end of the traverse, unless disengaged. The rapid traverse is at the rate of 40 feet per minute, and is independent of the feeds. When the rapid traverse is engaged, the pilot wheel on the turret carriage is automatically locked against rotating. The rapid traverse mechanism is mounted as a unit in the rear of the headstock, and is belt-driven direct from the drive pulley. Eight reversible feed changes are provided in each apron, and additional feeds may be obtained through pick-off gears at the headstock end of the machine. Feeds from 1/256 to 1/2 inch per revolution, and all standard thread feeds, are secured through one set of change-gears. Special change-gears may be provided when required.

The handwheel on both carriages is so geared to the lead-screw nut through a differential gear that one revolution of the handwheel moves the carriage 1 inch. In thread chasing, the wheel is locked by means of a plunger pin to facilitate catching the thread at each pass. An observation dial located on each carriage for the longitudinal feed is graduated and geared to show 7 inches of circumferential movement for each 1 inch of carriage travel. Several adjustable clips are provided on the beveled surface to act as observation stops, and, in addition, both carriages are equipped with automatic feed trips. The toolpost cross-feed dial is graduated in thousandths of an inch. The two aprons are duplicates as to the internal parts, and the several sub-assemblies of parts may be removed as units after taking off end or front plates.

Four automatic longitudinal trips are provided for the toolpost carriage and six longitudinal trips for the turret carriage; automatic trips are also provided for the cross-feed. The stop-rod for the longitudinal feed of the square turret is graduated in inches and mounted on an arm that can be swung out of the way when it is desired to have the square-turret side carriage pass the chuck. The six turret stop-screws are arranged in groups of three in separate heads. Each head can be moved quickly by withdrawing the pin that positions it in one of a row of holes 1 inch apart. A fine adjustment of each stop is obtained by screwing it through the head, while a coarse adjustment is made by backing out a hollow-head set-screw to permit sliding the stop through to approximately the point desired.

The taper attachment is mounted on the rear of the bed, as may be seen in Fig. 4. It is intended for use in turning tapers up to a maximum of 6 inches per foot, in lengths of

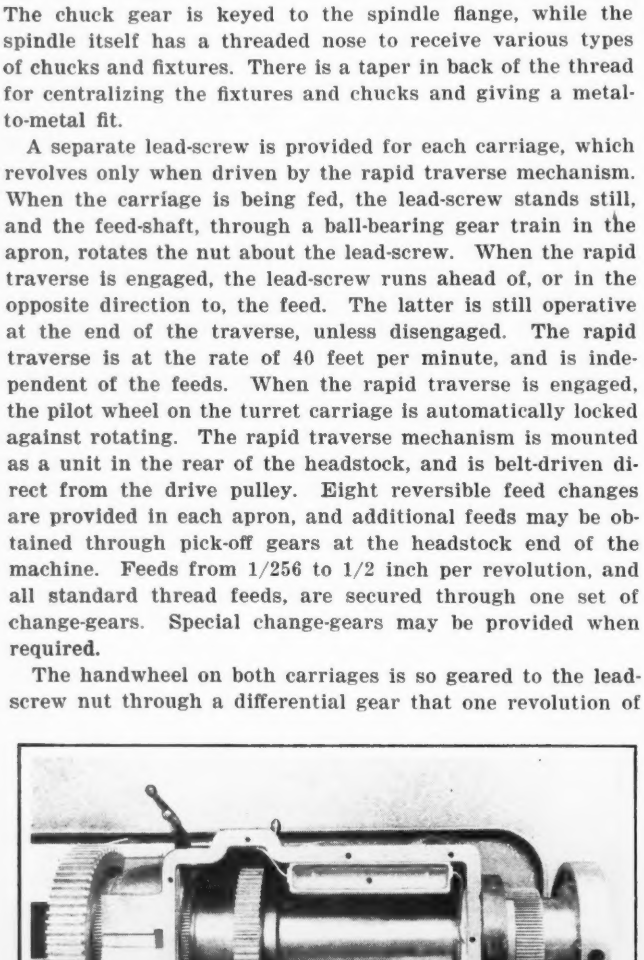


Fig. 3. Internal Arrangement of Important Members of the Headstock

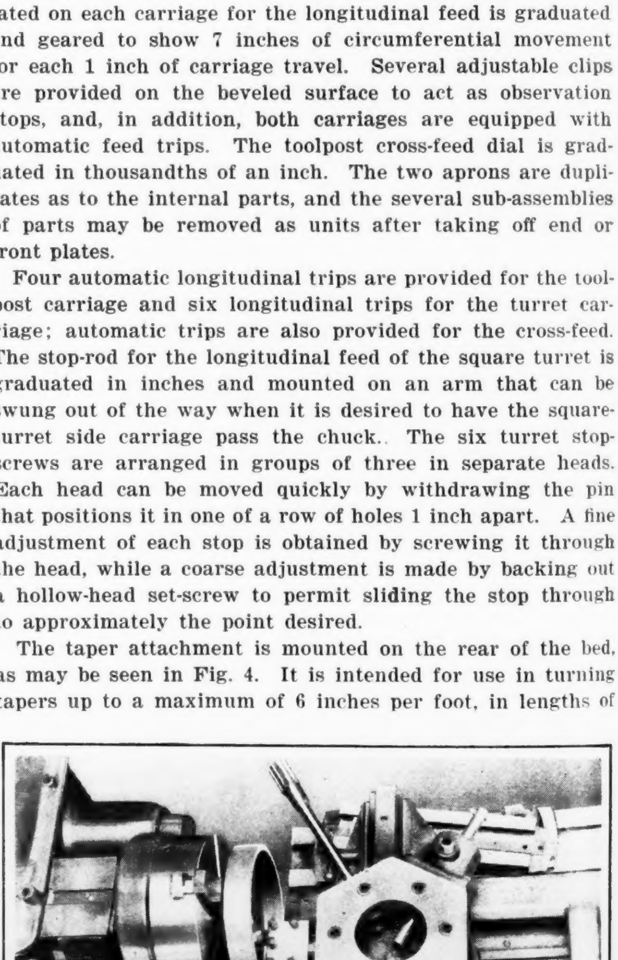


Fig. 4. Top View, showing Cross-feeding Turret and Taper Attachment

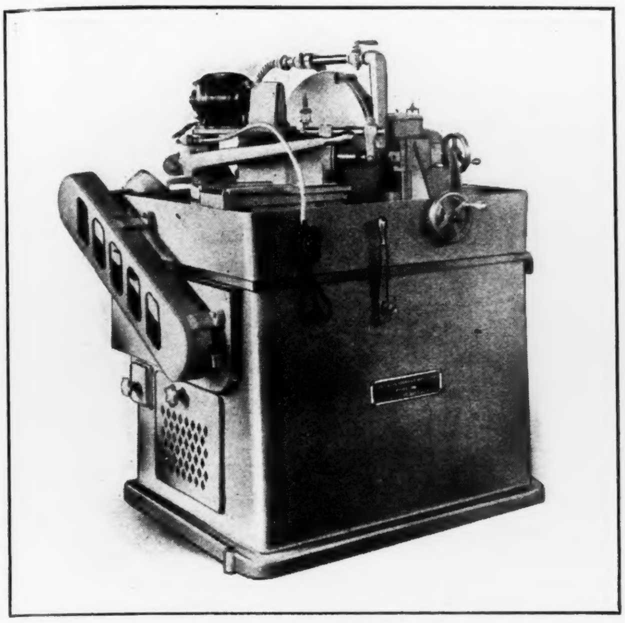


Fig. 1. Fitchburg Improved Machine for grinding Poppet Valves

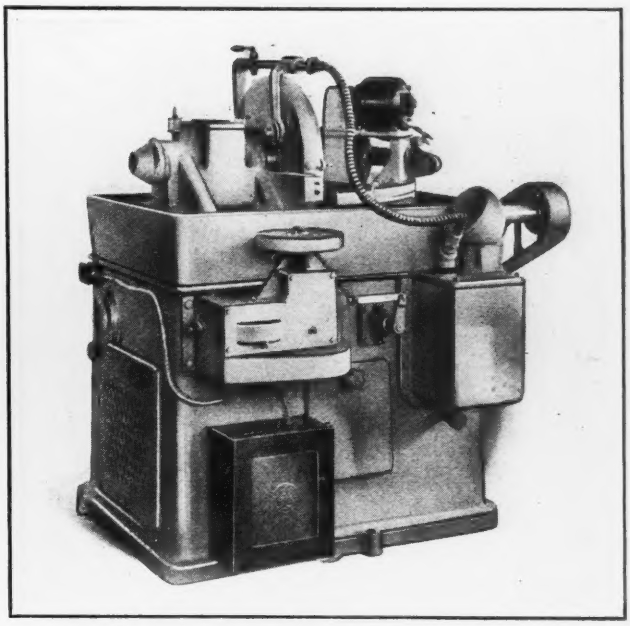


Fig. 2. Rear View of the Motor-driven Valve Grinding Machine

15 inches. On the fixed-center turret type of machine, the taper attachment is connected with the square turret on the side carriage, but on the cross-feeding turret machine, the taper attachment is connected with the cross-feeding turret, unless otherwise specified. On the larger machine, a power angular feed to the square-turret toolpost may be furnished for machining work to angles beyond the scope of the taper attachment. The net weight of the 21-inch machine is approximately 11,000 pounds, and of the 28-inch machine, 19,000 pounds.

FITCHBURG POPPET VALVE GRINDING MACHINES

Motor- and belt-driven machines of an improved design are being placed on the market by the Fitchburg Grinding Machine Co., Fitchburg, Mass., for grinding the angular seats of poppet valves. The machines have been designed with a view to obtaining ease of operation, rigidity, and simplicity. The operator merely loads and unloads the spring collet chuck, the grinding being automatic.

The feed of the rear wheel is accomplished by means of a plate cam at the rear of the machine. The feed mechanism may be allowed to run continuously or may be stopped automatically at the completion of a cycle by operating the lever at the front of the machine. To obtain different feeds, the cam can be readily changed, and the speed of the cam is varied by means of change-gears. This speed governs the number of cycles per minute, or, in other words, the number of valves ground per minute, and should depend upon the size and material of the valves.

On the machine illustrated, the work-head has an individual motor drive, but on the belt-driven machine, a single pulley is provided. On both machines, the work-head has an adjustable reciprocating motion to traverse the valve across the face of the grinding wheel. The head may be arranged for grinding valves of from 30 to 60 degrees, inclusive. The grinding wheel can be trued while the wheel-slide is being operated by the cam, and the truing device is so placed that no adjustment is necessary after truing the wheel.

On the motor-driven machine, the main driving motor is enclosed within the base, while for the belt-driven machine, a countershaft equipped with ball bearings is provided. All belts are guarded. The machines are compact, requiring a space of only 45 by 45 inches. A few other specifications are as follows: Capacity of the collet chucks, from 5/16 to 5/8 inch; dimensions of the grinding wheel, 18 by 3/4 by 5 inches; grinding wheel speed, 1276 revolutions per minute; and net weight, about 3400 pounds.

LANDIS PORTABLE PIPE THREADING OUTFIT

A pipe threading outfit that can be readily moved from place to place in oil fields, for cutting and threading pipe and casing, is shown in the accompanying illustrations. This equipment is used by the Pure Oil Co., Columbus, Ohio, and

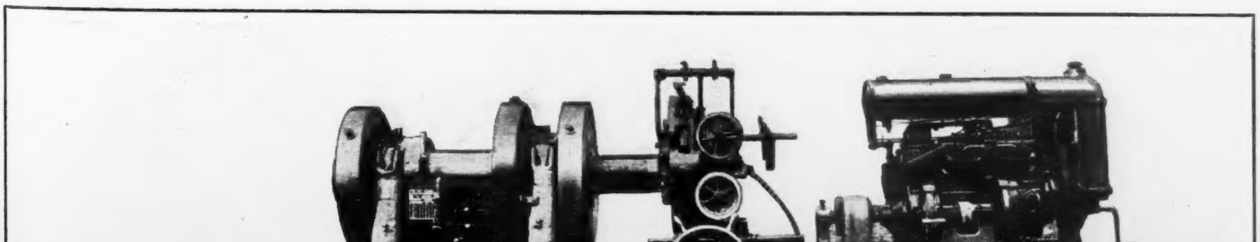


Fig. 1. Landis Portable Pipe Threading Outfit for Oil-field and Maintenance Service

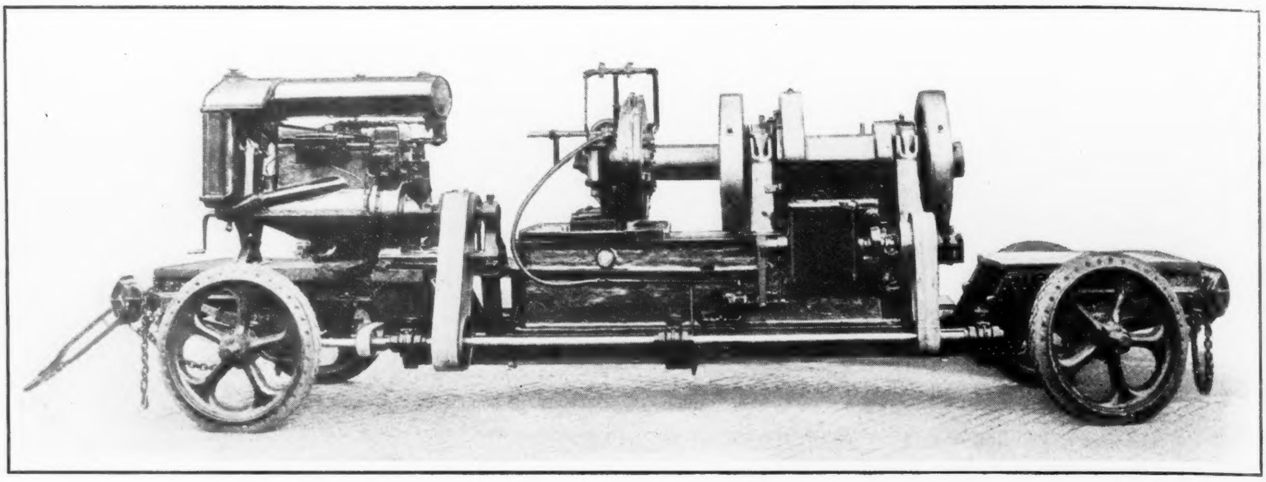


Fig. 2. Rear View, showing the Drive from the Tractor Engine to the Two Machines

consists of a specially built trailer on which are mounted an 8-inch pipe threading and cutting machine, a chaser grinder, and a Fordson tractor engine for driving the two machines. The trailer was built by the Highway Trailer Co., Edgerton, Wis., and the pipe threading and cutting machine and the chaser grinder, by the Landis Machine Co., Inc., Waynesboro, Pa.

In Fig. 1, which shows a view of the operating side of the machine, the chase grinder may be seen to the right of the other machine, directly in front of the tractor engine. This grinder is also provided with a small tool-rest and a plain wheel, which may be used for any miscellaneous grinding in the field. The method of driving the machine is illustrated in Fig. 2. From the tractor engine, the power is delivered through a belt and pulleys to a lineshaft which is supported along the trailer frame. At the rear end of the lineshaft may be seen the belt which drives the gear-box of the pipe threading and cutting machine through a single pulley. All speed changes are made in the gear-box. Near the front end of the trailer may be seen the belt that goes under the trailer to drive the chaser grinder. The spindle of this machine is driven direct by belt from the lineshaft.

The chuck of the pipe threading and cutting machine may be clearly seen in Fig. 3. It has a universal adjustment and is self-centering. Flange grips are also furnished. When removing pipe from this machine, or when making up or "breaking" flanges, the operator stands on the platform shown. While intended primarily for oil field service, this equipment could also be used for maintenance work in large plants, or by firms having plants scattered within a certain area.

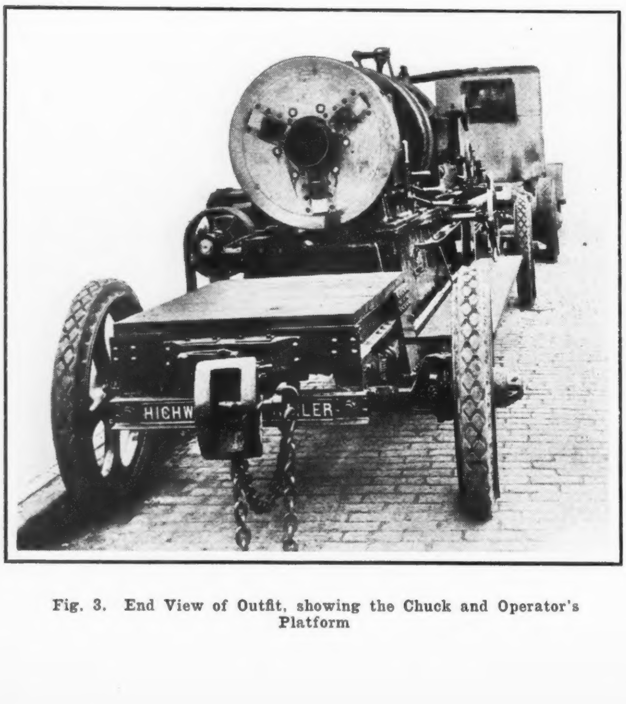


Fig. 3. End View of Outfit, showing the Chuck and Operator's Platform

J. N. LAPOINTE HYDRAULIC BROACHING MACHINE

A variable-speed hydraulic broaching machine, known by the designation No. 3L, has recently been brought out by the J. N. Lapointe Co., New London, Conn. In this machine, the cutting speed can be varied from 0 to 24 feet per minute, with a fast return speed of 60 feet per minute. If desired, the return speed can also be varied from 10 to 180 feet per minute. The speed changes can be made while the machine is running or when it is stopped, only a few seconds being required to adjust the machine to any predetermined rate of speed. The control arrangement is mounted on a control shaft which runs parallel to the cross-head ways and which can be locked at any cutting speed required.

The total stroke of the draw-rod is 56 inches, the machine being provided with an automatic stop for controlling the length of the stroke. This stop is of the spring and plunger type and requires no wrench for its adjustment; it can also be set, at will, for automatic return. Not only does this stop permit a variation of the stroke, but complete control is also provided by a hand-lever which permits the ram to be stopped or started in any position, either on the cutting or return stroke.

The machine, being built on the hydraulic principle, is provided with a low-pressure relief valve which automatically opens when the ram meets with undue resistance. This feature prevents the broach from being broken in case it should be backed up against the inside of the faceplate. The pressure for the hydraulic system is supplied by a Hele-Shaw variable-delivery multi-plunger hydraulic pump, made by the American Fluid Motors Co., Philadelphia, Pa. This pump is a compact unit resembling, in size and general appearance, an electric motor of the enclosed type. It is of full ball-bearing construction, thereby practically eliminating wear, and is self-lubricating and requires no packing. Each pump is subjected to a thorough test, before being installed, at a pressure of 1500 pounds per square inch.

For driving the pump, either a countershaft or a direct-connected electric motor drive may be used, a 7 1/2-horsepower motor being recommended. The speed of the pump is 900 revolutions per minute. The base for the motor is arranged to take any make of motor.

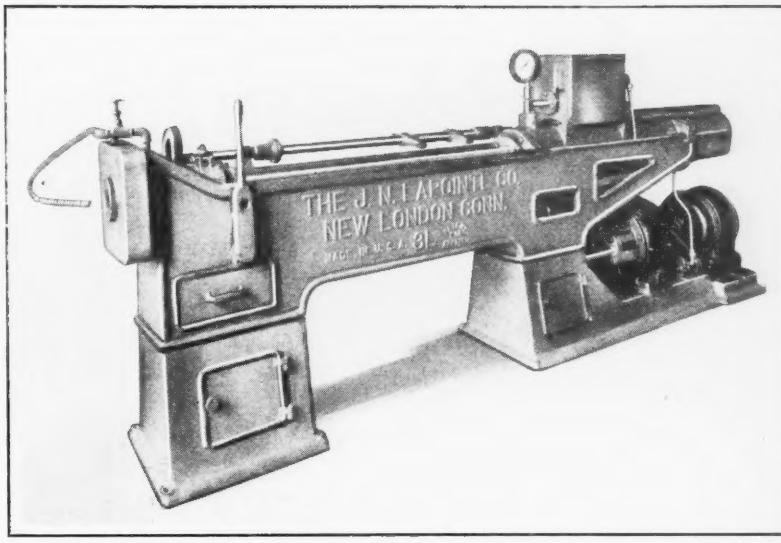
Particular attention is called to the design of the pressure cylinder. Ports are cored in the cylinder to eliminate piping and possible leakage. Only two pipes are used in the entire hydraulic system, and these are made of extra heavy copper, neither being over 27 inches in length. The fast return valve is cast separate from the main cylinder, and all cored recesses are machined, which insures that no sand or gritty substances remain in the casting. The cylinder is cast to government specifications for hydraulic iron. It is 7 inches in internal diameter, and is mounted on the rear end of the machine bed, being bolted at its forward end to a cross-piece which is cast integral with the bed. At a pressure of 1000 pounds per square inch, which is the maximum pressure

recommended, and that for which the relief valve in the pump is set, a pull of 31,400 pounds is exerted on the draw-rod. The pulling capacity is slightly more than that of the No. 3 and No. 3B screw-type broaching machines. The efficiency of the hydraulic machine, as compared with the screw-type machine of like capacity, is very much greater. The screw-type machine has an efficiency of 35 per cent, 65 per cent of the power being taken by the friction in the screw, nut, gears, clutches, etc. The efficiency of the hydraulic machine is stated to be 90 per cent.

A system of linkage connects the operating lever and the control shaft with the pump. The latter is directly connected to an automatic valve, which, during the return stroke of the ram, permits the oil that produces the pressure on the cutting stroke to be transferred from one side of the piston to the other without passing through the pump. A reservoir above the pressure cylinder accommodates the excess oil during the working stroke. Connections are so arranged that when the relief valves in the pump open under pressure, they exhaust into a reservoir in the base of the machine, and the oil is pumped back into the reservoir above the pressure cylinder by a small auxiliary pump. The reservoir above the pressure cylinder provides means for filling the system, which can be done in a few minutes, about twenty gallons of oil being required. This reservoir should not be filled to the top, unless the ram is in position to begin the return stroke. When the ram is in this position, the oil is at its highest point in the reservoir, rising and falling at each stroke of the machine. Any good grade of medium-heavy motor oil is recommended. Coolant for the broach is supplied by a Brown & Sharpe geared pump. Lubricant is supplied to the broach, both when it enters the work and when it is leaving.

A time-saving feature added to the machine is a removable chip pan, located in the front part of the machine bed. As the broach is being pulled through the work, the coolant washes the chips from the tool down into this pan, which is perforated to allow the coolant to pass into a reservoir. Only a few seconds are required to remove and empty the chip pan. This reduces the time formerly required to remove the chips from inside the bed.

Among the specifications not referred to in the foregoing may be mentioned the hole in the faceplate, which is 5 inches in diameter, and the vertical adjustment of the draw-head, which is 1 5/8 inches above and below centers. The driving pulley is 18 inches in diameter and has a 5-inch flanged face. As standard equipment, the machine is provided with one reducing and one pull bushing. It weighs 6000 pounds, and occupies a floor space of 12 1/2 feet by 26 inches.

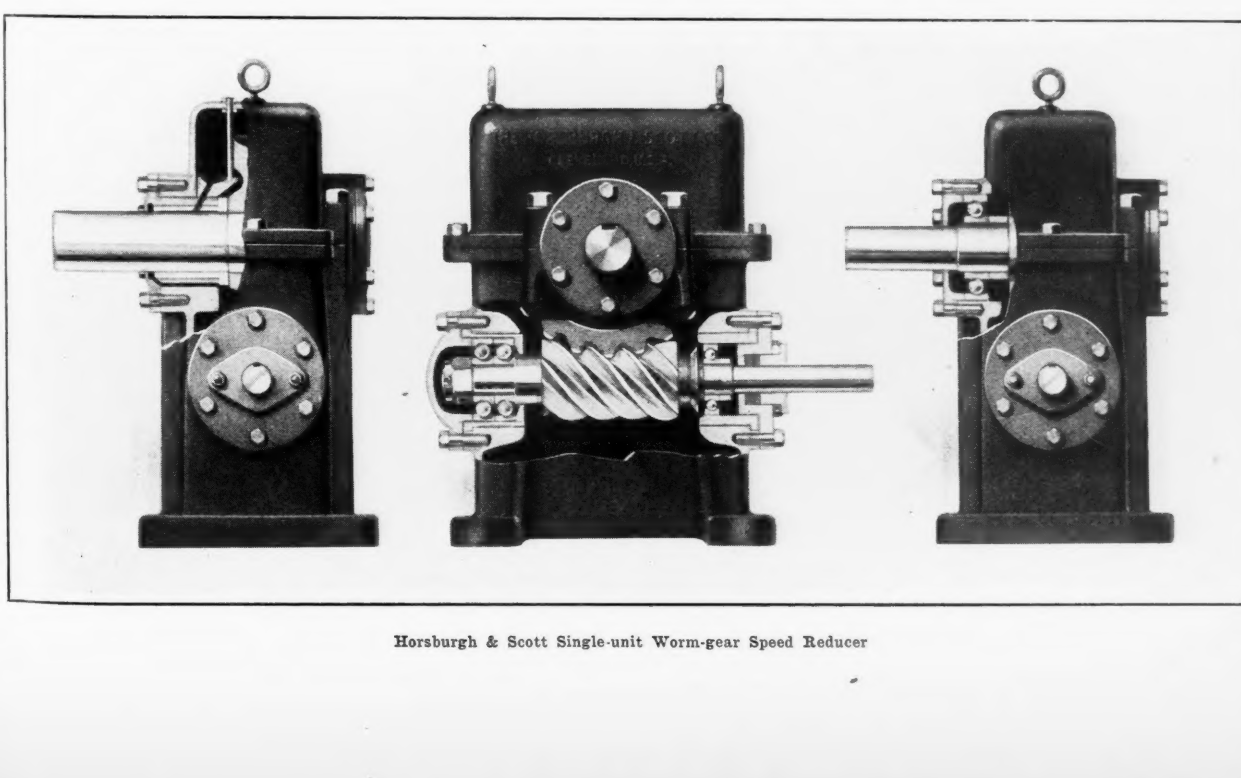


J. N. Lapointe Hydraulic Broaching Machine

It is stated that production has been increased on an average of 100 per cent, and in many cases by a higher amount, as compared with the company's screw-type machines of similar size. In one case, a screw-type machine produced 30 pieces per hour, and three machines were required to obtain the necessary output of 90 pieces hourly. One hydraulically operated machine now gives an output of 90 pieces per hour, and therefore replaces three of the older type machines, displaces two operators, and saves the floor space required for two machines.

HORSBURGH & SCOTT WORM-GEAR SPEED REDUCERS

Single-unit worm-gear speed reducers are built by the Horsburgh & Scott Co., 5114 Hamilton Ave., N.E., Cleveland, Ohio, for various reductions up to 100 to 1. For larger reductions—up to 3000 to 1 and over—which must be obtained in one housing, double-reduction units are built. There are three types of single units, type B, in which the worm is below the gear, as illustrated; type T, in which the worm is above the gear; and type V, in which the gear-shaft is vertical. The choice of these three types offers considerable


Horsburgh & Scott Single-unit Worm-gear Speed Reducer

latitude in placing the speed reducer and motor in a given installation.

One of the features of this line of reducers is that the mounting, especially as regards the gear-shaft diameter and bearings, depends upon the type of load for which the particular reduction is intended. When the load is principally torque, a lighter shaft and ball bearings may be used; when there is torque with a light suspended load, roller or journal bearings and a slightly heavier shaft may be used; but when there is torque with a heavy overhung load, heavy bronze journal bearings and a large diameter shaft are used. All of these conditions can be cared for in the same standard type of housing with slight changes in the design of the small parts to take care of the different types of bearings and the variations in the shaft diameter.

The worm and shaft are a solid forging of a special low-carbon steel which is carburized, casehardened, and ground all over, including the thread surfaces. The worm-shaft is mounted on ball bearings of which the rear bearing is of the duplex radial thrust type, and the front bearing of the straight radial type. The inner race of the latter bearing is fastened to the worm-shaft, but the outer race is free to float axially, thereby allowing for expansion and contraction of the shaft. The duplex radial thrust rear bearing permits normal rotation of the worm in either direction.

The gear is of a special bronze, and the housing is a gray iron casting. A solid type of bronze journal bearing is used for the gear-shaft, this bearing being pressed into a cast-iron sleeve, which, in turn, is securely held between the upper and lower halves of the housing. The sleeve is fastened firmly by means of cap-screws which pass through holes in the flange, and is further held by a clamp inside the housing. This clamp performs the additional duty of carrying an oil-wiper and its receptacle, which insures complete lubrication of the gear-shaft bearings regardless of the gear speed.

ROCKFORD ROTARY "RIGIDMIL"

To accommodate production milling jobs that can be done most advantageously in a rotary fixture, the Rockford Milling Machine Co., Rockford, Ill., is building a "Rigidmil"

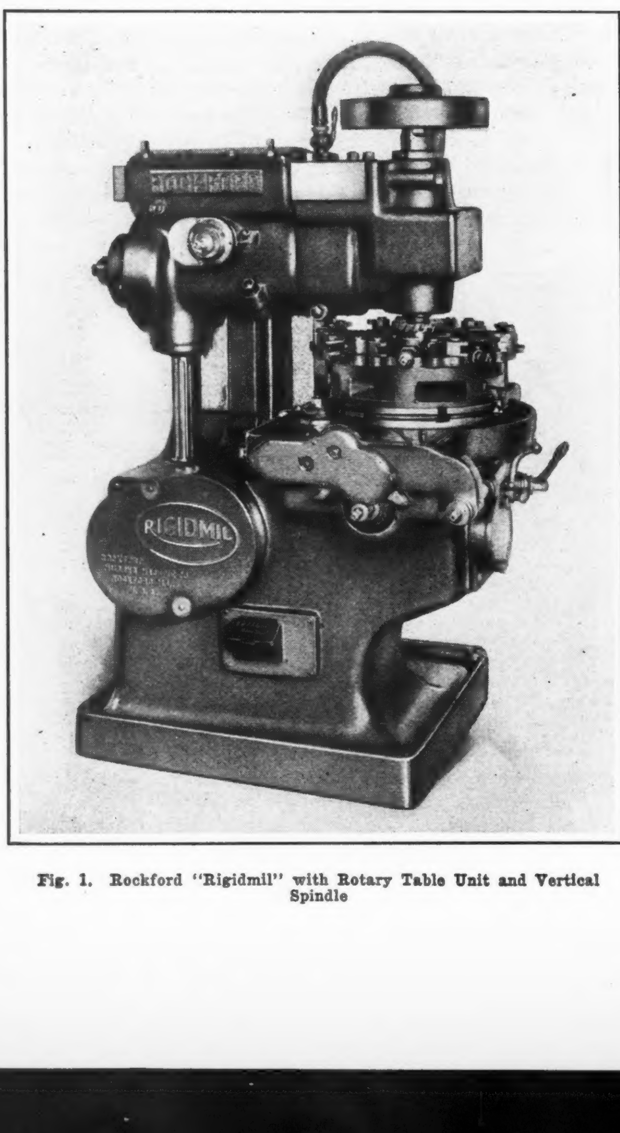


Fig. 1. Rockford "Rigidmil" with Rotary Table Unit and Vertical Spindle

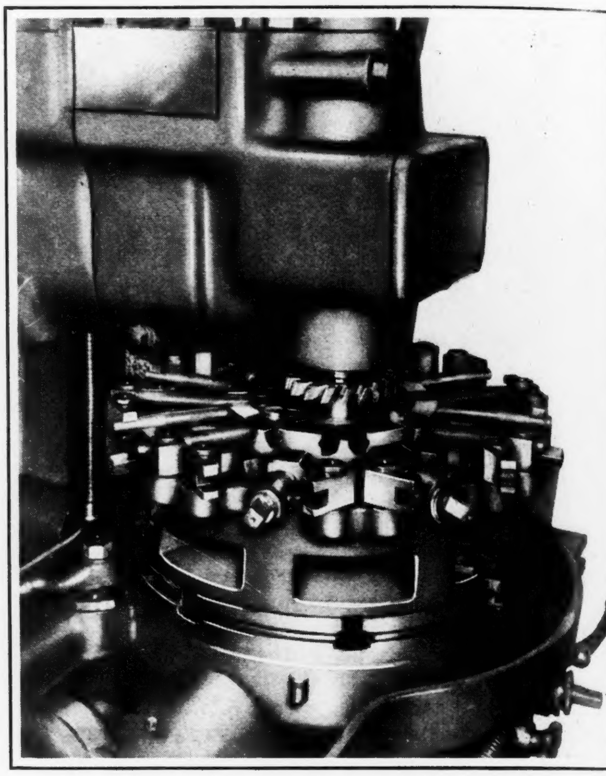


Fig. 2. Close-up View of a Typical Operation on the Rotary "Rigidmil"

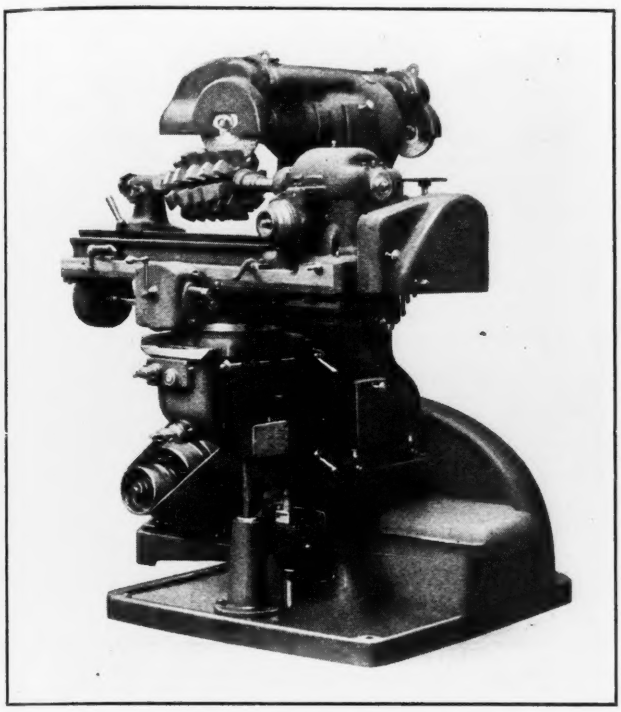
equipped with a power-feed rotary table unit in place of the regular table. A vertical-spindle attachment is mounted on the regular spindle head. The rotary table unit is an actual part of the machine instead of merely an attachment, since it is mounted directly on the saddle slide. The table is locked in position by means of a clamp which comes in contact with the gib on the saddle slide. A nut on the front of the saddle is revolved to adjust a screw that regulates the cutter depth.

The drive is taken from the gear that is regularly splined to receive the table screw, which, in turn, through a train of gears and a clutch, drives the worm for obtaining the feed. Provision is made in this train of gears for a range of feeds that is satisfactory for milling work near the outer edge of the table or at a smaller diameter. Any change of feed within this range can be made after removing the end gear cover, by changing the position of one stud and substituting the proper gears.

The worm is provided with ball end-thrust bearings and is carried in eccentric bronze bushings that permit adjustments for wear. The worm-wheel is cast solid on the table, and acts as a stiffening rib. The worm and the worm-wheel are enclosed in a cored compartment and are submerged in grease.

Lubrication of the table is accomplished by rollers in pockets identical to those used in the saddle slide of the regular table. The base of the table is made in two sizes, a larger one suitable for work that is to be milled in the inner position, and a long one for work milled in the outer position. The long base provides a full bearing on the saddle slide. In order to handle a large amount of cutter lubricant and chips, the table is made with a large oil-pan and is furnished with a screen through which the lubricant is returned to the base.

The vertical spindle attachment is bolted to the arm of the regular spindle head, in the upper position, and clamped around the quill in the lower position. A bevel pinion mounted on the regular spindle drives a mating gear on the attachment spindle. The latter is identical in the nose and general dimensions to the main spindle. A flywheel is splined to the upper end to prevent chatter. The speed of the attachment spindle is one-half that of the main spindle. When it is desired to use the horizontal spindle, the vertical spindle attachment can be readily removed. The rotary table is 17 inches in diameter.



Pfauter Full-automatic Hob Sharpening Machine

PFAUTER FULL-AUTOMATIC HOB SHARPENING MACHINE

A hob sharpening machine with an automatic travel of the table back and forth, automatic indexing from one flute of the hob to another, automatic setting of the hob toward the grinding wheel after a complete revolution of the hob, and automatic rotation of the hob in relation to the table travel to suit the spiral of the flutes is shown in the accompanying illustration. This machine, which is known as the Pfauter hob sharpening machine, has recently been placed on the market by the O. Zernickow Co., 21 Park Row, New York City. The automatic setting of the hob toward the grinding wheel is said to insure the removal of a uniform amount of stock from all teeth and thus make the hob true-running. This automatic setting of the hob can be regulated, and the mechanism disconnected, if desired. In the latter case, the setting can be accomplished by hand.

Indexing of the hob to suit the number of flutes is accomplished through change-gears, and the movement to suit the lead of the spiral flutes is obtained through a separate change-gear system. Indexing can also be accomplished by hand when this is preferable. The grinding operation takes place during both the advance and the return of the table. The grinding dust is taken by a vacuum dust remover and deposited in a water tank. At the back of the machine column there is a second grinding wheel and below it a vertically adjustable support. This wheel and rest may be used for grinding milling cutters, drills, and other tools. A truing device is furnished for both wheels.

The machine is driven through a single pulley, either from a countershaft or motor. It may be used for sharpening any cutter or tool with spiral flutes, up to 10 5/8 inches in diameter and up to 13 3/4 inches in length. Tools with straight flutes can also be ground. Face mills up to 13 3/4 inches in diameter may be sharpened by means of the special attachment. One operator can tend three or four of these machines, or else sharpen tools on the rear grinding wheel while the front wheel is automatically grinding a hob.

Some of the important specifications of the machine are as follows: Maximum automatic longitudinal travel of table, 17 3/4 inches; cross adjustment of table, 6 inches; vertical adjustment of table, 8 7/8 inches; amount table can be swiveled in either direction, 45 degrees; maximum center distance, 21 3/4 inches; and net weight of machine, 2310 pounds.

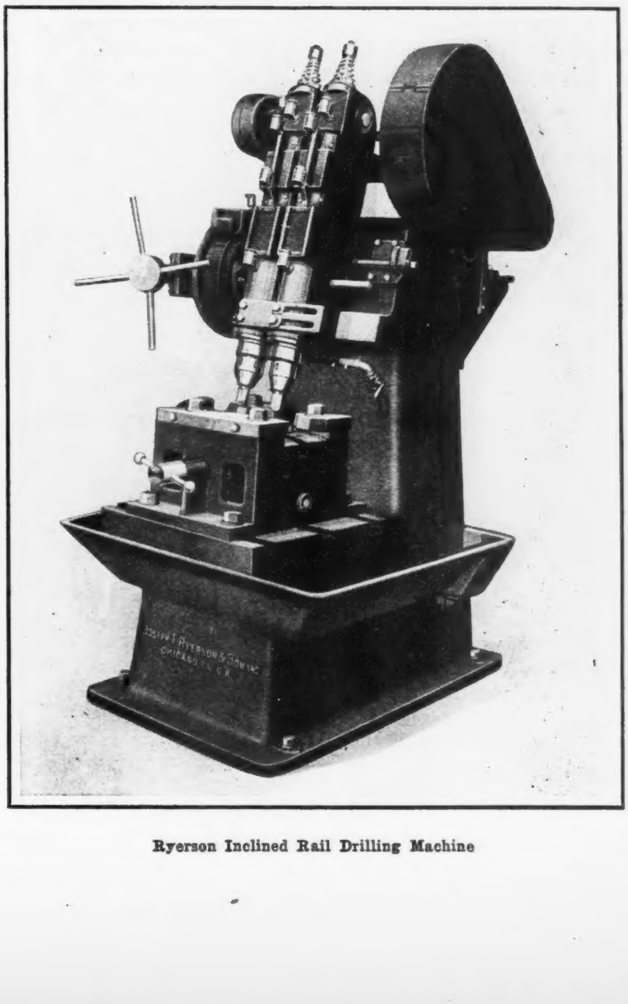
RYERSON INCLINED RAIL DRILLING MACHINE

An inclined type of drilling machine has been added to the rail reclamation outfit built by Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill. This outfit consists of a high-speed friction saw for cutting off the ends of used rails, and drilling machines for drilling new holes in the rails. When rails have been reclaimed in this manner, they are ready to be put back into service on main roads or side tracks, depending upon the number of times they have been reclaimed. The new inclined drilling machine eliminates the difficult handling and turning of the rails in the drilling operation. With this machine, the rails are simply slid into place and drilled while lying on one side in the natural skidding position.

The machine may be provided with two or three spindles inclined at an angle of 15 degrees. Speed- and feed-boxes are provided on the left-hand side of the machine, and the motor is mounted on a bracket at the rear. A coolant pump and tank are located inside the frame, the coolant being returned to the tank by a generous apron and strained to permit continuous use. A heavy vise is used to hold the rails.

The spindles are controlled by means of a single capstan wheel. When this wheel is turned in a clockwise direction, the drills are lowered rapidly to the rail, and a slight further movement engages the feed. An adjustable knock-out is provided for disengaging the feed at the completion of the operation. The spindle is made from a carbon-steel forging, and the thrust is taken by a ball thrust bearing. The spindle nose is 3 inches in diameter, and has Acme threads to receive the clamping collet of the chuck. This holds the bit closely without overhang. Two spindle speeds of 110 and 150 revolutions per minute, and three feeds of 0.0082, 0.0107, and 0.0139 inch per revolution, are provided. The spindle speeds are changed by removing the cover on the speed-box and interchanging gears on the horizontal drive shaft. Changes in feed are made in a similar manner, with an extra set of gears furnished for the third feed.

A silent chain is used for driving from the motor to the initial drive shaft, and only six gears are used between the drive shaft and the spindle. The final drive to the spindle



Ryerson Inclined Rail Drilling Machine

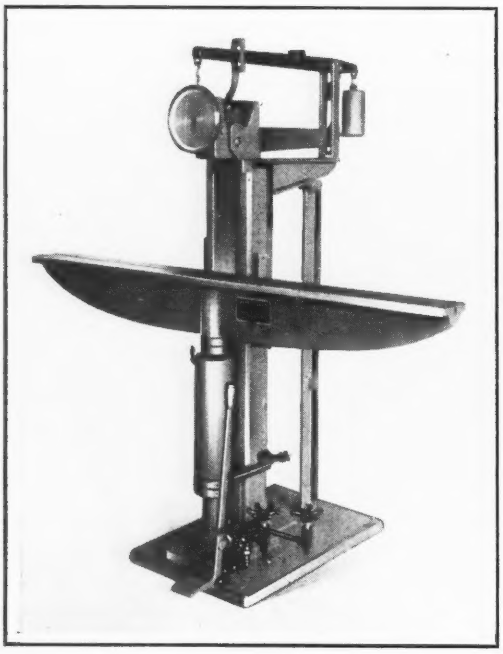


Fig. 1. Olsen Automobile Spring Tester

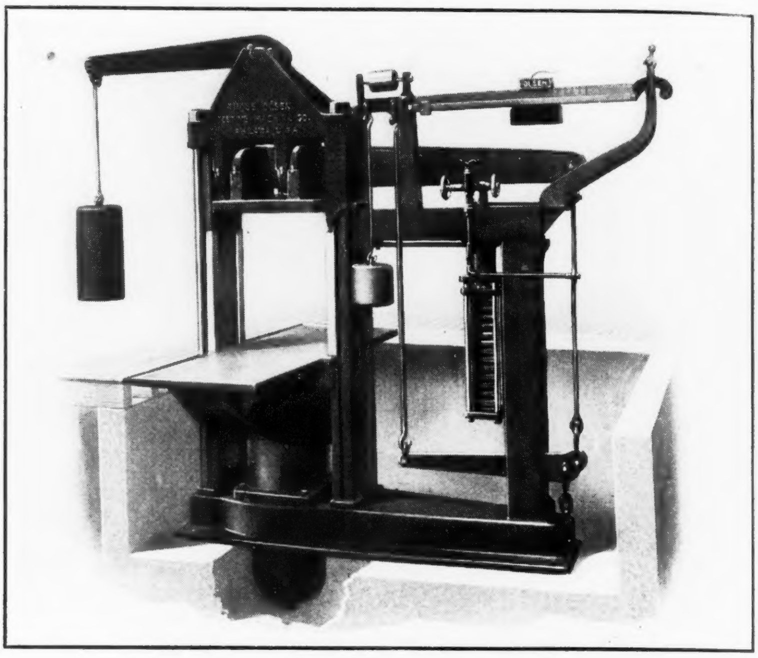


Fig. 2. Locomotive and Car Spring Testing Machine

is through a set of wide-face herringbone gears of fine pitch. All bearings are provided with removable bushings of a bronze alloy.

OLSEN TESTING MACHINES

Three machines recently developed by the Tinius Olsen T sting Machine Co., 500 N. Twelfth St., Philadelphia, Pa., for testing automobile, locomotive, and car springs, and brake beams, are shown in the accompanying illustrations. The machine illustrated in Fig. 1 is an automatic weighing automobile spring tester intended for production service. The springs to be tested are mounted and held on the table in accordance with specifications, and the load applied or removed by merely operating the foot- or hand-lever that controls the hydraulic or pneumatic pressure system. For the production testing of springs, the pressure mechanism is adjusted to compress the springs to a predetermined amount, and the load is then automatically read from the dial.

The machine has a gap of 15 inches between the head and the table, with the table in the extreme upper position. As the table has a movement of 12 inches, the maximum clearance between the head and the table is 27 inches. The table is 6 feet 6 inches long by 6 inches wide. The machine may be obtained with a cylinder and piston for operation up to a maximum load of either 1000 or 2000 pounds, operating on air or water pressure of 100 pounds per square inch. If preferred, the maximum load may be 6000 pounds, in which case the machine is operated by hydraulic pressure of 1000 pounds per square inch. A dial attachment may be provided for automatically indicating the travel of the table at all times.

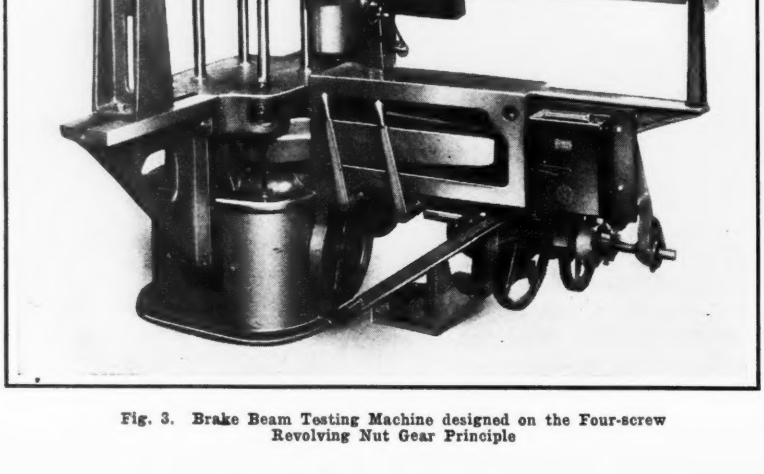


Fig. 3. Brake Beam Testing Machine designed on the Four-screw Revolving Nut Gear Principle

In the past, this type of machine has been built with screw gearing and operated by a motor, but with the present design, greater production is obtainable in testing a large number of similar springs. The machine weighs about 1500 pounds.

An improved locomotive and car spring testing machine of the hydraulic lever weighing type is shown in Fig. 2. This machine is built with the weighing table level with the floor so that the springs can be easily placed on the table. The weighing table can be obtained either flat, as shown, or with wear plates and roller-bearing carriages on which springs may be mounted. Special trucks can also be provided from which the springs may be rolled on the table.

The weighing system consists of a multiple lever system with knife-edges inserted in machined slots, ground to an edge and terminating in a scale beam that weighs the load to the full capacity. The machine has a clearance of 24 inches between the uprights, a maximum clearance of 28 inches between the table and head, and a table stroke of 24 inches. It is built in three sizes having a capacity of 100,000, 125,000 and 150,000 pounds, and weighing 10,000, 11,000, and 12,500 pounds, respectively.

Fig. 3 shows a brake beam testing machine designed on the Olsen four-screw revolving nut gear principle. This machine is fitted with a dial vernier screw beam, and the Olsen automatic feature may be provided. Brake beams can readily be placed into and removed from the machine, as no portion of the screw gearing projects above the cross-head. A direct-connected motor drive is furnished. The machine illustrated has a capacity of 100,000 pounds and weighs 5750 pounds. A machine is also built with a capacity of 50,000 pounds, weighing 4250 pounds.

WARNER & SWASEY UNIVERSAL TOOLING EQUIPMENT

Three additions to the universal tooling equipment described in March MACHINERY are being announced to the trade by the Warner & Swasey Co., Cleveland, Ohio. These additions are available for the Nos. 4 and 6 turret lathes manufactured by the company, and include a multiple cutter-head, a vertical slide-tool, and a turret-slide support. At the right in Fig. 1 is shown the multiple cutter-head, which is useful for taking turning, facing, chamfering, and boring cuts at the same time that tools on the cross-slide are being used. The multiple cutter-head is mounted on the turret, the vertical construction avoiding interference of the head with the cross-slide. Forged cutters can be used, and these are held in the vertical slot by various combinations of set-screws. Each cutter may be set and adjusted independently of the others.

The cutter-head is made from a steel casting. A series of tie-screws and bushings prevents the sides from springing apart when the forged cutters are clamped in place. These screws and bushings can be shifted to the various holes to suit different positions of the cutters. A rocker bushing provided for the center hole allows the use of square-shank forged boring cutters. Two set-screws for clamping a cutter shank in the center hole are located at right angles to two others, so as to insure substantial bearing surfaces for the cutter shanks.

The vertical slide-tool, shown at the left in Fig. 1, is another rigid turret tool for taking recessing, back-facing, boring, chamfering, and similar cuts. The slide proper is supplied with a large micrometer dial which permits quick and accurate resettings. Clips are furnished which may be placed on any of the graduations to facilitate resettings. Forged cutters can be easily and quickly set in this slide-tool by the use of a split bushing. The set-screws furnished for holding each cutter shank are placed at right angles to each other to insure proper bearing surfaces for the cutters. Boring-bars can be used after the split bushing is removed. A taper gib may be adjusted to compensate for wear of the slide. The slide may be clamped in any position by means of the binder screw.

The support shown in Fig. 2 is intended for use when it is necessary to have a large overhang of the turret-slide, such as is usually required with heavy cuts, interrupted cuts, or long work where it is not possible to use a pilot. This turret-slide support is clamped on the bed between the cross-slide and the turret unit, and the front end of the turret-slide enters the upper portion of the support. The arrangement allows for coarse feeding by making the turret-slide rigid. Both vertical and horizontal adjustments are provided to compensate for wear. This support is particularly useful with the vertical slide-tool shown in Fig. 1, when overhead piloting cannot be resorted to and there is considerable overhang of the turret-slide.

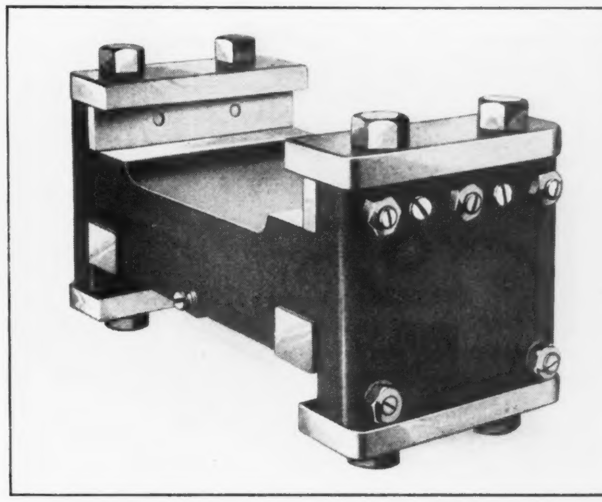


Fig. 2. Support for the Overhanging End of a Turret-slide

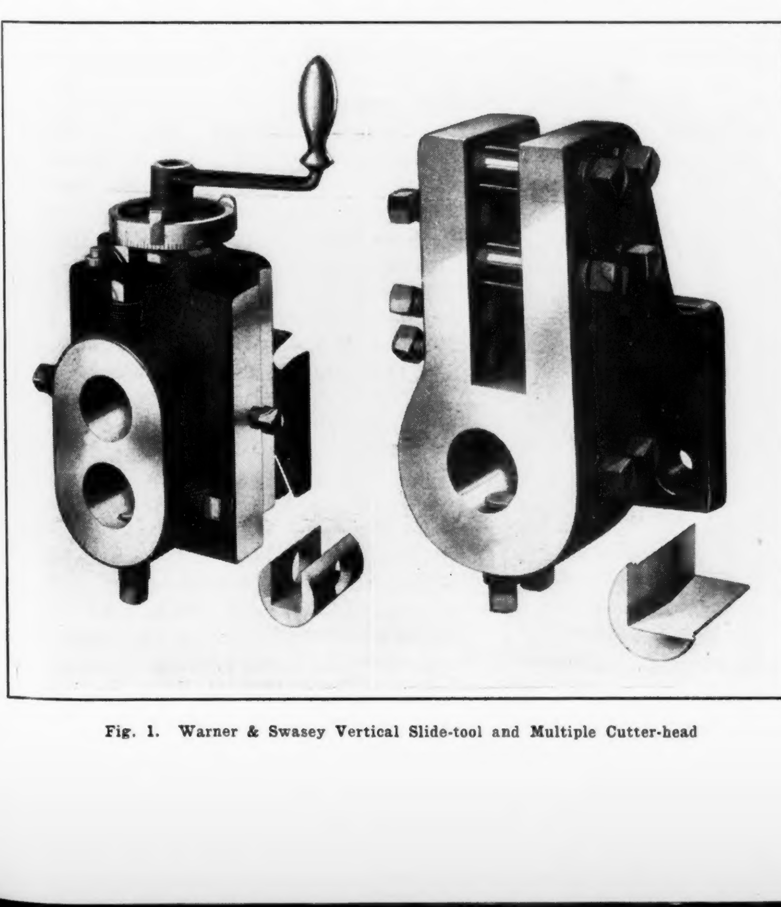


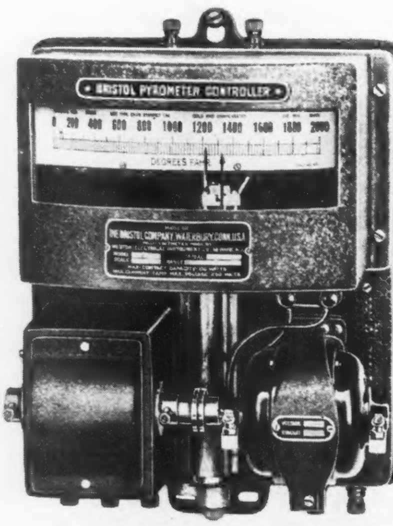
Fig. 1. Warner & Swasey Vertical Slide-tool and Multiple Cutter-head

BRISTOL PYROMETER CONTROLLER

The model 479 pyrometer controller now being introduced to the trade by the Bristol Co., Waterbury, Conn., has a high resistance pyrometer movement and can be used for all temperatures up to 3000 degrees F. A feature of the controller is a scale 7 inches wide, which is the same as that furnished on the indicating pyrometer model 420. The motor for this controller is connected to a horizontal shaft by means of a non-metallic coupling, which reduces friction and noise. The mechanism that transmits power from the cam to the switch and that causes the switch to move up and down about four times a minute, is accurately set up and adjusted by means of set-screws.

The plane of travel for the switch is fixed and designed to be horizontal when installed for operation. The millivoltmeter movement is accurately adjusted so that the pointer swings in a plane parallel to the plane of motion of the switch. After the pointer has been aligned to follow the proper path, the anvil or plate against which the pointer tip or steeple is pressed, is adjusted so that the steeple will always have sufficient clearance relative to the plate but will still move a minimum distance when the switch is brought up against it. The steeple which takes the pressure when the switch is brought up is, in effect, a small inverted wedge, the base of which is brought to rest on the anvil plate. The apex of this wedge is in contact with the small button which throws the switch over. The complete moving mechanism that supports the switch is assembled in one unit.

An improvement in this controller is a safety adjusting mechanism for setting the position of the index at the point to which it is desired to bring the temperature. A small hinged cover encloses the adjusting knob, and the knob cannot be operated until the cover is opened. The act of opening the cover automatically forces the switch mechanism to its lower position, where it is entirely free from the pointer. With this provision, there is no possibility of the operator damaging the millivoltmeter movement by attempting to set the index while the switch is in contact with the pointer steeple.



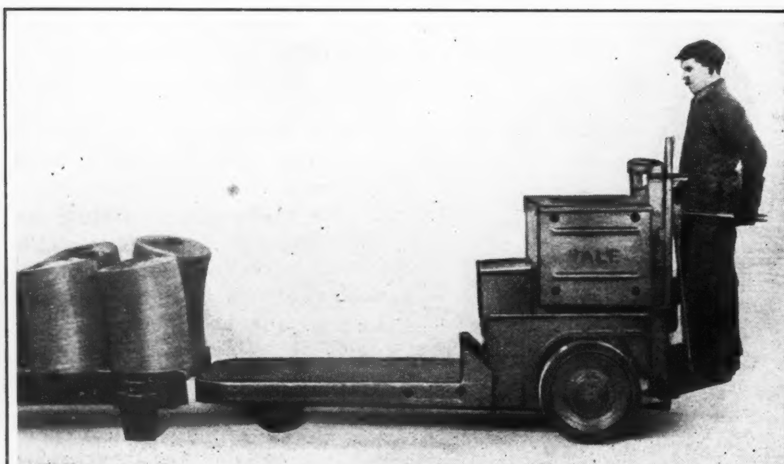
Bristol Pyrometer Controller for All Temperatures up to 3000 Degrees F.

The top of each of the small buttons against which the steeple rests when the switch is making contact is about 1/4 inch in diameter. When the pointer is near the desired temperature, a knife-edge situated midway between the two buttons that operate the switch determines whether the contact is on the high or the low side. The pointer is depressed on either side of the knife-edge, and there can be no neutral position. After being guided to one side or the other by the knife-edge, the steeple operates against the top of the button and throws the switch in to the maximum or the minimum position.

YALE ELEVATING PLATFORM TRUCK

A new elevating platform truck, designated as K23E, has recently been brought out by the Yale & Towne Mfg. Co., Stamford, Conn. Although this truck is not of the high lift type, like the K22 described in September, 1923, MACHINERY, it does embody the self-loading feature. The truck has a larger turning radius and is of a narrow width, so that it is easy to drive in and out of box cars or narrow aisles. The steering pivots are made of hardened steel and are equipped with bronze bushings and a high-pressure lubricating system. These, as well as the large tires, make steering easy even when carrying a full load.

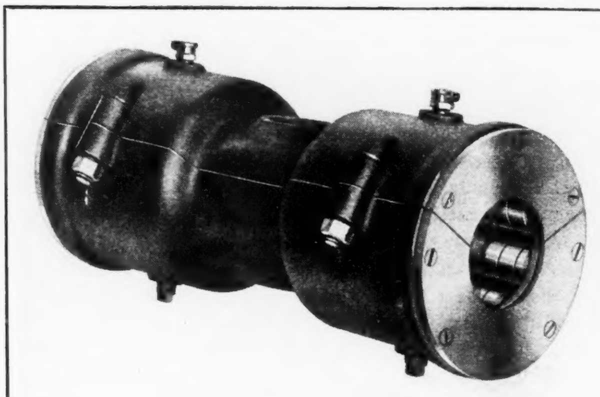
The elevating mechanism is of the triple spur-gear type, and consists essentially of the same unit as is used in the K22 truck, the major replacing parts being interchangeable between the models. The platform is raised by means of two large eccentrics mounted on the shaft of the hoist unit, which draw the platform forward and upward on links. Mechanical upper and lower limit stops assure simple and safe operation of the lift mechanism. One of the features of the K series of trucks built by this company is the spur-gear unit power axle. This constitutes a sub-assembly that is interchangeable in all models. The controller is the same as on all Yale industrial trucks. By having the majority of parts, units, and sub-assemblies of this truck standard and interchangeable with other models in the K series, operating advantages and economies are effected when two or more different trucks of the series are in operation in one plant.



Yale Elevating Platform Truck

HYATT "NARROW-CENTER" LINESHAFT ROLLER BEARING

A lineshaft roller bearing of new design, which fits any type of housing and which is split to permit easy installation, constitutes the latest development of the Hyatt Roller Bearing Co., Newark, N. J. The box is dumb-bell shaped and has a twin split roller assembly mounted at each end. The center section, which does not have a bearing surface, is narrowed down to average plain bearing dimensions so as to fit hangers having the narrowest frame openings. The bearing element is made up in the "New Series" type recently adopted by this company for all high-duty bearings, the rollers being of the regular helically wound design. The bars through the rollers maintain equal spacing and alignment, and form a strong cage or retainer.



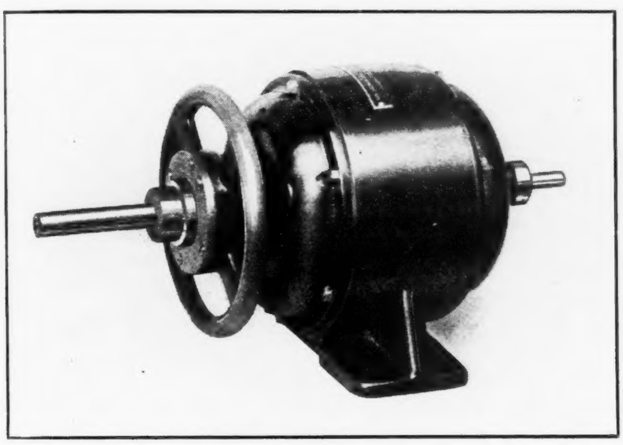
Hyatt "Narrow-center" Lineshaft Roller Bearing

The box is built in two sections, of which the lower part forms two-thirds, and the top, one-third. With this design, the machined joint is brought well above the oil level and prevents leakage of oil. Four bolts are tightened to seal these sections around a shaft, the bolt bosses being staggered so that the top cannot be improperly fitted. It is mentioned that in a recent case where a plain bearing had to be replaced, the worn bearing was removed and a Hyatt bearing of the new design replaced within seven minutes while the shaft was turning. However, the practice of applying bearings while shafts are turning is not generally recommended. One filling of lubricant every three or four months is said to be sufficient, regardless of the service.

At the present time the bearing is manufactured in the following sizes: 1 7/16, 1 15/16, 2 3/16, 2 7/16, and 2 15/16 inches. For large sizes of hangers requiring bearings up to 4 15/16 inches, the old line of U. G. and B & S type of Hyatt bearings is being continued.

COLUMBIA VARIABLE-SPEED TRANSFORMER

In a patented device manufactured by the Columbia Industrial Machinery Co., 4020 W. Lake St., Chicago, Ill., a slight rearrangement of the elements of an ordinary roller bearing has resulted in a variable-speed transformer. Speed variation is obtained by changing the relative positions of the points of contact between the rollers and races. A feature pointed out by the manufacturer is that the power transmitting capacity of the device is high in proportion to the weight and bulk. Four sizes of the unit, of 1/4, 1, 3, and 5 horsepower capacity, weigh 75, 150, 230, and 290 pounds, respectively. The maximum speed reduction in machines of average proportions is 14 to 1, and the minimum, 2 to 1. Thus, a variation in speed of 7 to 1 is easily achieved, and much greater variations are possible. In the illustration, the constant-speed shaft projects from the right-hand end of the housing, and the variable-speed shaft, from the left-hand end. The efficiency of the device, or the output power, with the maximum reduction, is said to be over 95 per cent, as compared with the input power. Hence, the heating of the transformer in operation is negligible. The device is totally enclosed, and all working parts run in an oil bath. This feature is particularly desirable for installations in which the unit may be exposed to dirt, grit, moisture, etc.

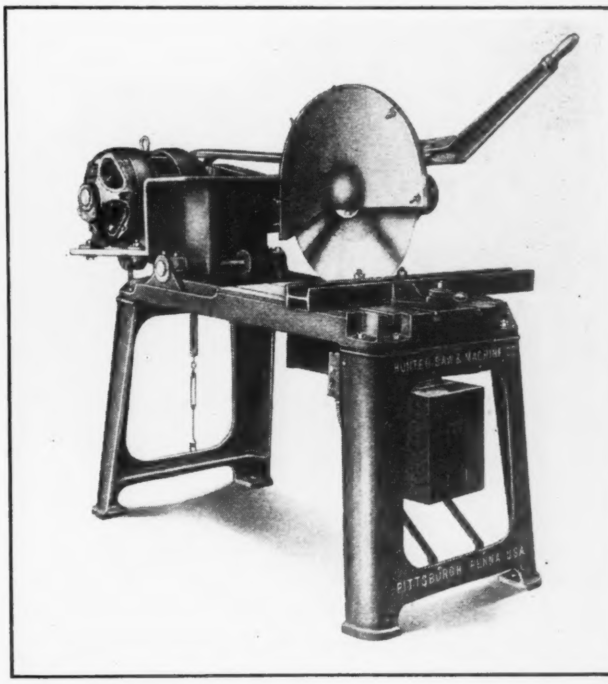


Columbia Variable-speed Transformer

HUNTER HIGH-SPEED METAL CUT-OFF SAW

A No. 1A machine designed with a circular toothed saw rotating at a high speed is being introduced to the trade by the Hunter Saw & Machine Co., 5662 Butler St., Pittsburg, Pa., for cold-sawing metal pieces such as light-section beams, channel- and angle-irons, brass, copper, structural, and welded tubing, pipe, steel moldings, etc. This machine has a number of improvements as compared with the No. 1 machine brought out some time ago. For instance, the tilting frame which carries the saw arbor at one end and the motor at the other, has been increased in size to permit handling heavier work. The motor base of this tilting frame has also been redesigned to accommodate either a 7 1/2- or a 10-horsepower motor.

The motor is keyed to the base to assure the proper alignment of pulleys, and a handwheel provides convenient belt adjustment. Increased belt width permits the operation of the machine with a lower belt tension and, consequently, a reduced bearing load. Machines equipped with alternating-current motors are provided with a push-button controlled magnetic starter having a low-voltage protection. A double-jaw quick-acting eccentric vise is another new feature of the machine. The maximum size saw that can be used is 24 inches. The peripheral speed of a 24-inch saw is 19,750 feet per minute. Equipped with a 7 1/2-horsepower motor and starter, the machine weighs about 1450 pounds, and with a 10-horsepower motor and starter, approximately 1500 pounds.

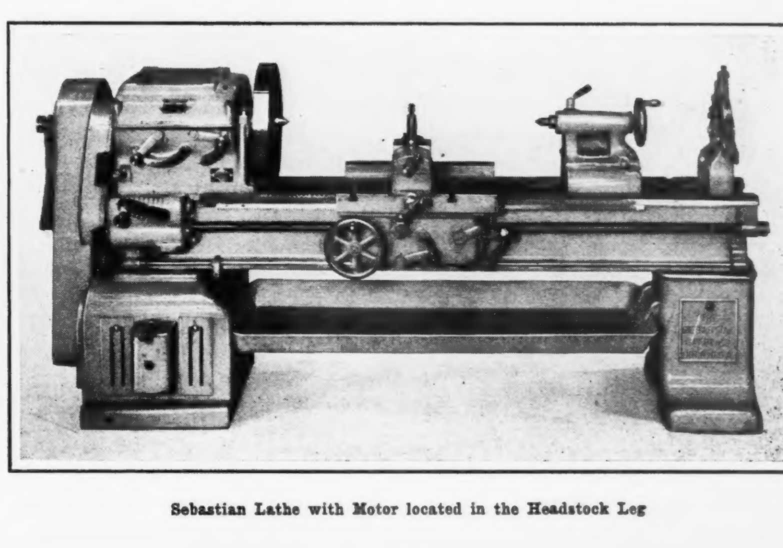


Hunter High-speed Metal Cut-off Saw of Improved Design

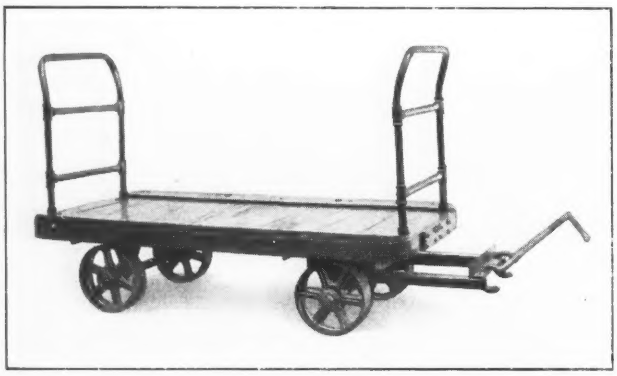
SEBASTIAN MOTOR-IN-LEG LATHE

Three sizes of lathes built by the Sebastian Lathe Co., Cincinnati, Ohio, may now be furnished with a motor drive, the motor being located in a pedestal leg beneath the headstock, as shown in the illustration. These sizes are the 15-, 18- and 20-inch machines. While the motor is completely housed, it is readily accessible, as the entire motor may be taken out through one end of the leg by removing four screws. The leg has two doors, one located at the front and the other at the back. The top of the leg is solid and is cast integral with the bottom.

In the 15-inch lathe, a 3-inch double belt is used in the drive from the motor to the headstock, and in the 18- and 20-inch machines, a 4-inch double belt is used. An easily adjusted idler pulley is supplied, and the belt is completely guarded. Motors up to 3 horsepower are furnished for the 15-inch machine, and up to 5 horsepower, for the 18- and 20-inch lathes.



Sebastian Lathe with Motor located in the Headstock Leg



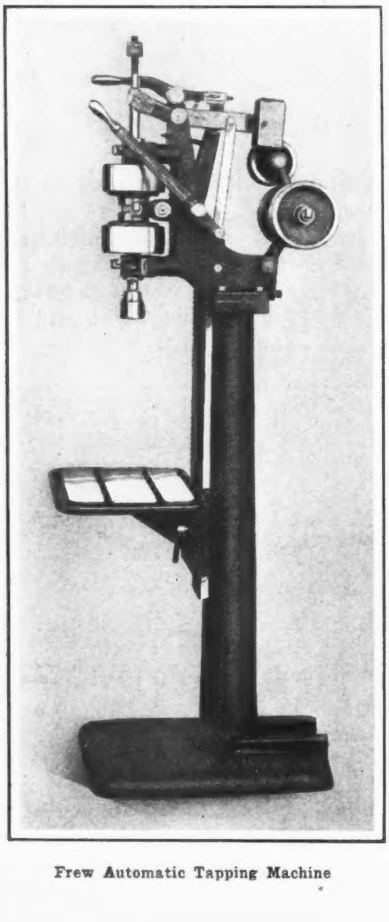
Crescent Trailer for Gasoline and Electric Industrial Tractors

CRESCENT TRACTOR TRAILER

A recent development of the Crescent Truck Co., Lebanon, Pa., is a trailer intended for use behind either gasoline or electric industrial tractors. This trailer is of the "fifth-wheel" steering type. The frame is built up of T-irons which are gussetted together and braced. The wheels are semi-steel castings, 12 inches in diameter, and are equipped with roller bearings. Bassick "Ruboid" wheels or wheels with automotive tires pressed on can also be furnished. Provision has been made for lubricating through "Alemite" fittings. The trailer is equipped with one set of pipe racks. The platform measures 3 by 6 feet, and is 15 1/2 inches high. The capacity of this trailer is 2 tons.

FREW AUTOMATIC TAPPING MACHINE

An automatic tapping machine has recently been placed on the market by the Frew Machine Co., 124 W. Venango St., Philadelphia, Pa., for tapping holes up to 1/2 inch in cast iron or steel. The particular advantage claimed for this machine is simplicity in operating and in making adjustments. In tapping a piece, the operator simply pulls down a hand-lever to cause the tap to enter the work, and at the moment that the tap reaches a predetermined depth, it automatically reverses and withdraws from the work.



Frew Automatic Tapping Machine

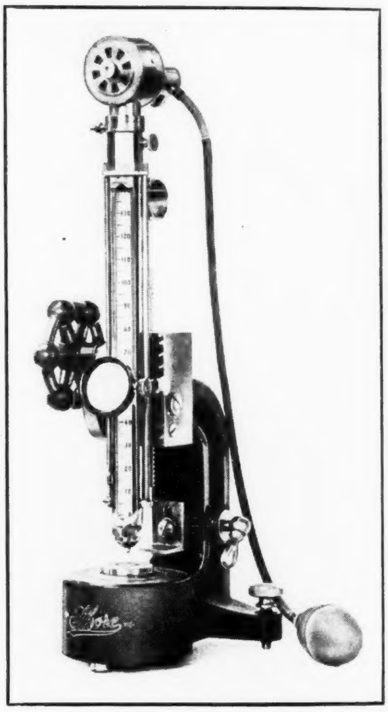
The column is provided with dovetail ways on which the table slides, the table being counterbalanced by a weight inside the column. On top of the column is mounted a headstock which carries all the operating mechanism. The ground spindle is carried in bronze bearings, which support it for practically the entire length,. and mounted on the outside of these bronze bearings are Timken roller bearings which carry the two driving pulleys.

The driving pulleys run in opposite directions, one furnishing the drive for tapping and the other for the reverse motion required to withdraw the tap from the work. The rotation of the pulleys is transmitted to the spindle by means of a friction member which is keyed to the spindle and has tapered faces that engage the pulleys. When the operator pulls down the handle on the right-hand side of the machine to feed the tap into the work, he causes the friction member to engage with the upper pulley and locks it in engagement. The tap continues downward until stops at the upper end of the spindle strike a latch, which releases the lock and engages the friction member with the lower pulley. This reverses the direction of rotation and withdraws the tap. The stops on the upper end of the spindle are, of course, set to suit the depth to which the work is to be tapped.

It is claimed that there are only two places where wear occurs, and that the wear can be taken up at these points by simply using a screwdriver and wrench. A patent is pending on the adjusting mechanism. The machine is built either for belt or motor drive. In the latter case, the motor may be mounted on the rear of the base to make the machine a self-contained unit.

SHORE IMPROVED SCLEROSCOPE

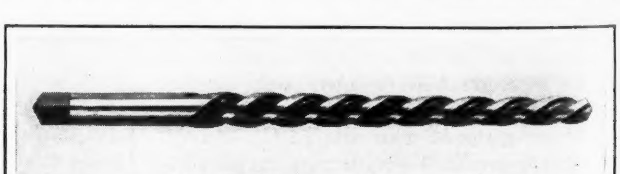
A model C-2 direct-reading scleroscope has just been brought out by the Shore Instrument & Mfg. Co., Van Wyck Ave. and Carll St., Jamaica, N. Y., to supersede the model C-1 instrument placed on the market about two years ago. In the new model, the auxiliary flat clamping foot-piece previously provided in the holding stand has been replaced by a graduated barrel unit. This unit is so reinforced that by using a comparatively heavy hardened-steel bottom cap, the test specimen may be clamped down directly under it. With this arrangement, the lightness in weight of the model mounted on the swing arm has been retained. The spot to be tested can be more easily located with the new instrument, and the pressure applied in closer proximity to it. The contact with the supporting anvil is more closely concentric, thus assuring the desired degree of uniformity and accuracy when making readings under adverse conditions.



Shore Improved Direct-reading Scleroscope

MORSE SPIRAL-FLUTED TAPER PIN REAMER

The latest addition to the line of tools manufactured by the Morse Twist Drill & Machine Co., New Bedford, Mass., is a spiral-fluted taper pin reamer, which is shown in the accompanying illustration. When made of carbon steel, this

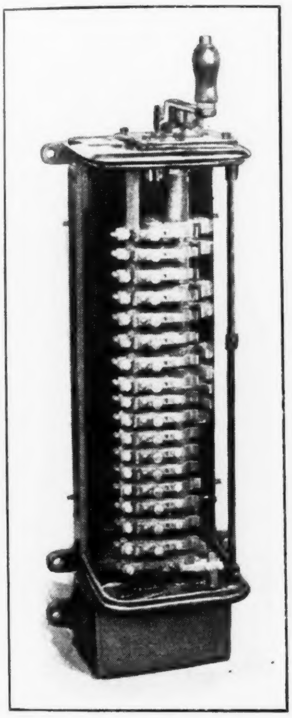


Morse Taper Pin Reamer with Spiral Flutes

reamer is known as the "No. 683," and when made of high-speed steel, as the "No. 1683." The reamer is designed to take an easy shearing cut and to clear itself readily of chips. It is particularly recommended by the manufacturer for production work. Nine sizes are made from No. 0 to No. 8, inclusive, the diameter of the small end of the smallest reamer being 0.119 inch, and of the largest reamer, 0.398 inch. The taper is 1/4 inch per foot.

GENERAL ELECTRIC DRUM CONTROLLERS

A completely standardized line of drum controllers is being placed on the market by the General Electric Co., Schenectady, N. Y. This line embodies new features of construction, and comprises units for general-purpose, crane-hoist or machine-tool applications, operating on either direct or alternating current. Several sizes are made in each group to cover a wide range in motor ratings, the smaller sizes being suitable for wall mounting, and the larger sizes, for floor mounting. One of the particular features in the mechanical construction is the skeleton type of frame used. This frame consists of a cast cap-plate and base to which rectangular steel bars are riveted. With this arrangement, it is unnecessary for the back of the switch to function as a framework to hold the top and bottom together. As a result, the switch is accessible from both the back and the front for the purpose of making adjustments, renewals, etc.



General Electric Drum Controller

Another feature particularly valuable in crane service is the interchangeability of operating handle mechanisms. A vertical operating lever or a spring-return mechanism may easily be substituted for the horizontal lever with which the switch is equipped, by using another dial plate. New-style self-aligning contact fingers are used. Where cross-arcing is likely to occur, adequate preventive barriers and blow-outs are furnished. Auxiliary contact fingers are provided for control circuits to the line protective switch. These circuits are designed to suit the requirements of the installation.

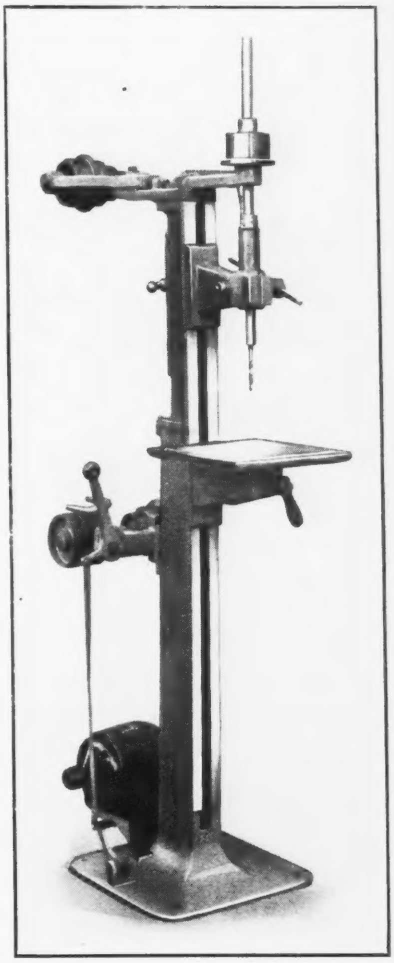
MODERN COMBINATION DRILL TABLE AND VISE

A combination drill table and vise larger than those made in the past by the Modern Machine Tool Co., Jackson, Mich., has just been brought out by the same firm. This 28-inch size is equipped with a table 27 1/2 inches in diameter, and the jaws open 12 inches. The jaws are 27 1/2 inches long and the guides, which are 10 inches apart and 4 inches wide, give a support of 18 inches. The movable jaw is actuated through a 1 1/2-inch square-thread screw which meshes a bronze nut 3 1/2 inches long. This large size unit is furnished complete the same as the smaller units, ready to set up on drilling machines. The complete drill table and vise weigh about 580 pounds.

Modern Combination Drill Table and Vise

ROBERTSON SENSITIVE DRILLING MACHINE

A 14-inch sensitive drilling machine designated by the trade name "Economy" and designed for drilling holes up to 1/2 inch has been placed on the market by the W. Robertson Machine & Foundry Co., 56-58 Rano St., Buffalo, N. Y. A ball thrust bearing is provided for the spindle, and the spindle is counterbalanced by a weight in the column which gives an even balance at all points in the rotation of the feed-lever. A spindle pulley is mounted on a stud bearing. The feed rack is cut in the spindle sleeve to assure a positive feed. Both the spindle head and the table are adjustable vertically and are clamped to the column by simply turning a hand-nut. A long tongue on the head and on the table enters a slot in the column to insure alignment of the parts. The belt can be shifted by hand or foot. Either a belt or a motor drive can be furnished.



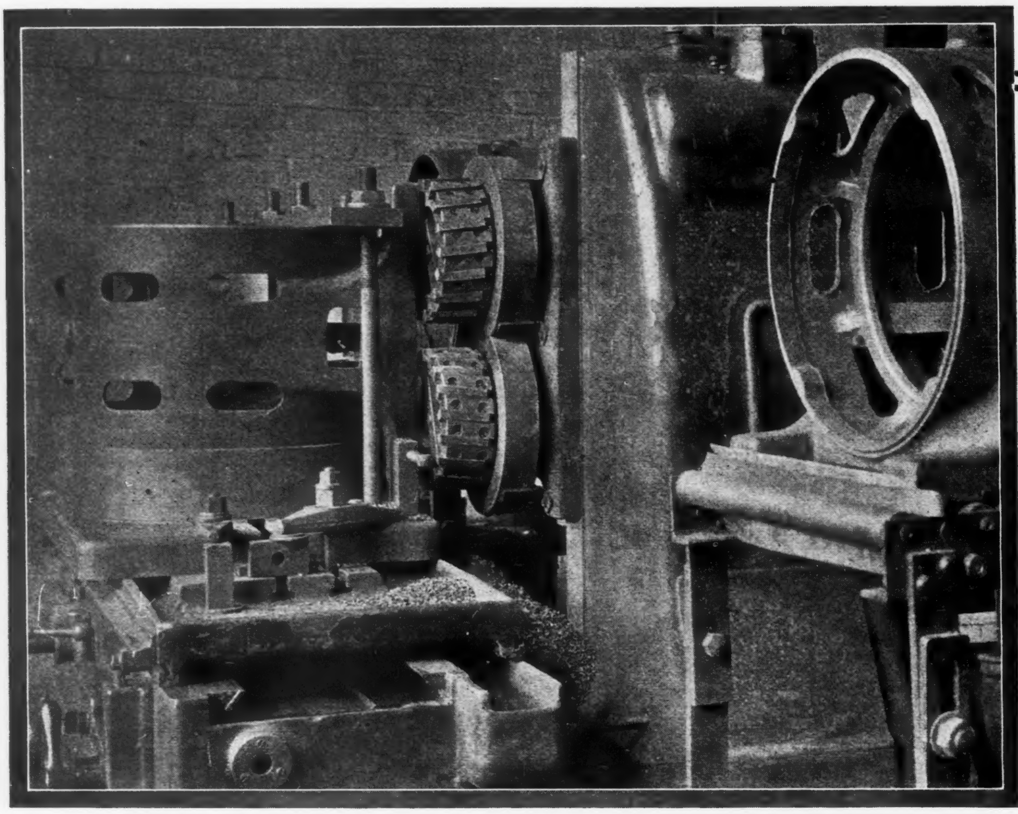
Robertson Drilling Machine

A few of the important specifications of this machine are as follows: Height of column, 63 1/2 inches; vertical adjustment of head, 8 1/4 inches; travel of spindle, 2 1/2 inches; distance from column to center of spindle, 7 1/8 inches; and weight of machine, approximately 325 pounds.

ROBERTSON TOOL GRINDER

A tool grinder known as the No. 12 "Economy Grinder" is a recent product of the W. Robertson Machine & Foundry Co., 56-58 Rano St., Buffalo, N. Y. The spindle of this machine is made of a high-carbon steel and runs in "Wear-ever" self-oiling bearings. These bearings are of a dustproof design, sleeve shaped, and 4 3/4 inches long. They are assembled into bored holes in the head and held in position by means of set-screws. There is a slot milled in the under side of each bearing in which a felt wick is inserted to carry oil the full length of the bearing.

The nuts on the ends of the spindle are of a safety design, completely covering the ends of the spindle thread. The



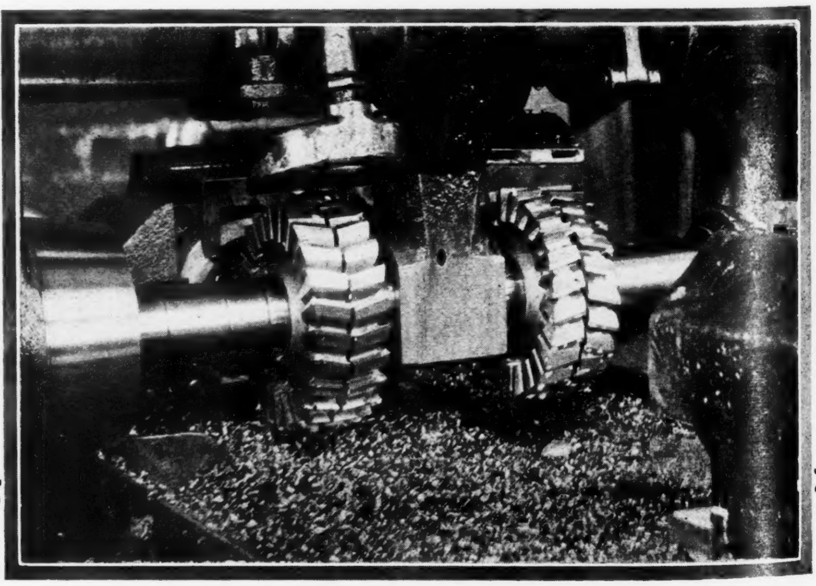
At the left is a Brown & Sharpe No. 33 Automatic set up with a simple two spindle attachment, boosting the production on motor frames. One of the two fixtures is loaded while the work in the other is being milled.

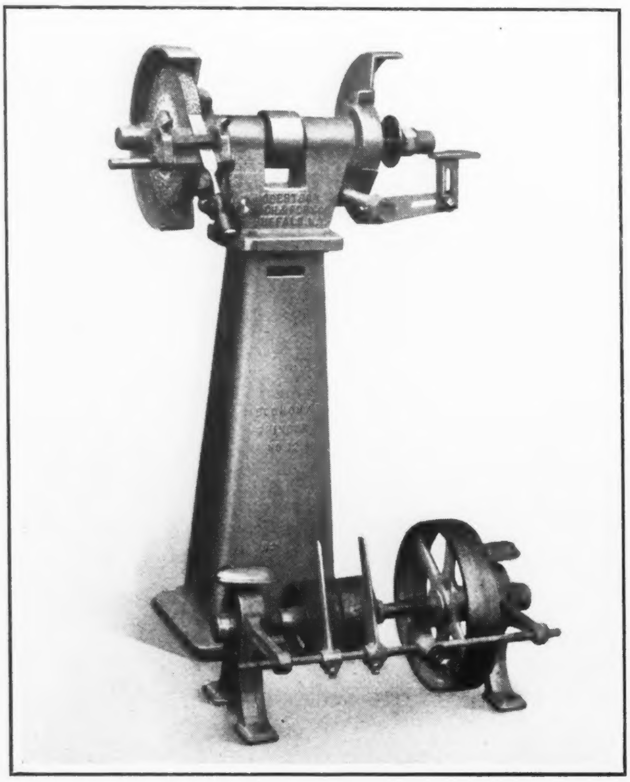
Cut Your Milling Costs *Automatically*

THE automatically reversible spindle and the automatic table control are the outstanding features of the Brown & Sharpe Automatics. They have already sent milling costs tumbling in a number of plants. Their possibilities are unlimited.

Send for "Brown & Sharpe Automatic Milling Machines," a booklet describing both the No. 21 and No. 33 machines and showing representative set-ups. Write today.

At the right a No. 33 Automatic operation is shown in which the automatically reversible spindle feature is employed. When the cut in the piece in the further fixture is finished, the table feed reverses automatically and the piece in the nearer fixture is brought up to cutting position at fast table travel. Meanwhile the spindle reverses automatically, so that the cutters will have the correct rotation.





Robertson Tool Grinder

safety guard is bored to fit a bearing 4 3/4 inches in diameter on which the guard can be adjusted to any opening at the work-rest. Both rests are adjustable in all directions. The attachment shown in front of the left-hand wheel may be furnished for grinding such tools as chisels, plane irons, etc. With this device, the tools are ground to the desired bevel and slightly concave, requiring little stoning. Wheels up to 12 inches in diameter by 2 inches wide can be accommodated. This grinder weighs about 60 pounds.

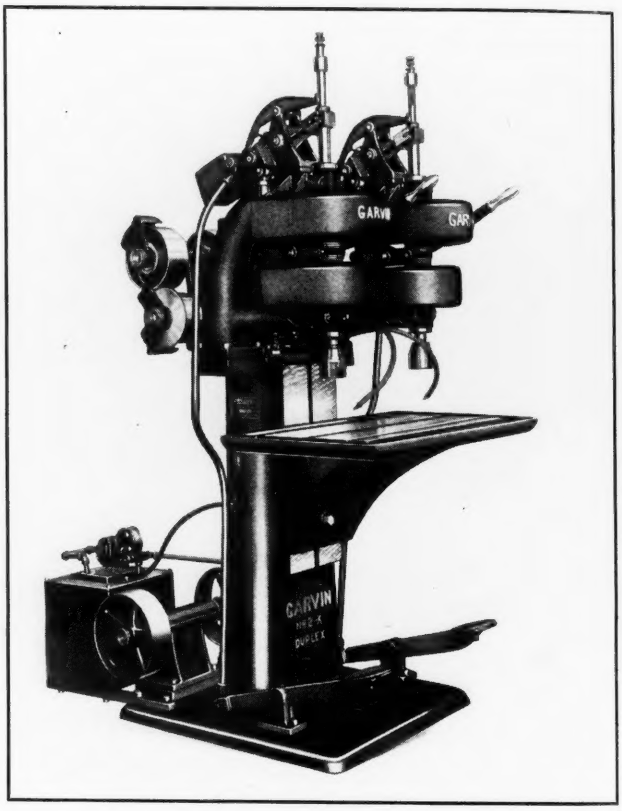
RAHN-LARMON PORTABLE LATHE

The motor-driven portable lathe shown in the accompanying illustration has been added to the line of lathes manufactured by the Rahn-Larmon Co., Cincinnati, Ohio. It is designed primarily for use in railroad shops, and is built in 16- and 18-inch sizes. The motor is of one-horsepower capacity; it is mounted on the headstock, and is connected by direct gearing to the all-geared drive head. A start, stop, and reverse push-button station is provided to facilitate the operation of the machine. Nine spindle speeds are obtainable. The lathe is mounted on steel wheels of a special design equipped with ball bearings, and may be easily transported about the shop by one man. Either a 5-, 6-, or 7-foot bed can be provided to meet requirements.

Rahn-Larmon Portable Lathe with Motor Drive

GARVIN AUTOMATIC TAPPING MACHINE

The No. 2-X duplex automatic tapping machine here illustrated has been added to the line of Garvin tapping machines built by the Western Machine Tool Works, Holland, Mich. With this equipment, it is possible to rapidly tap holes of



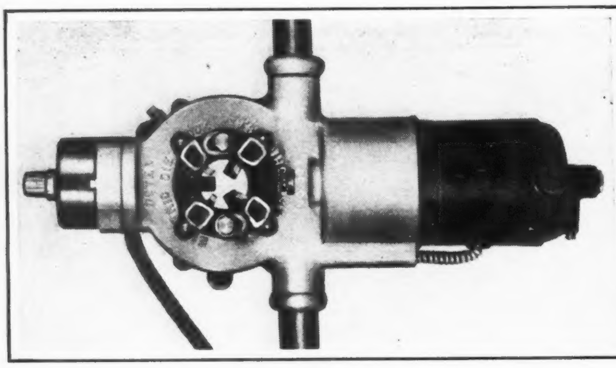
Garvin Duplex Automatic Tapping Machine

two different sizes. The machine is equipped with Timken tapered roller bearings and can be furnished, as illustrated, with a pump and tank for cutting lubricant. Both a hand- and foot-control are provided. Each head has a capacity for driving 1/4- to 7/8-inch U. S. standard taps in cast iron or from 1/4- to 3/4-inch, in steel. The pipe tap capacity is 1/2 inch in cast iron and 3/8 inch in steel.

OSTER ELECTRIC DIE-STOCK

A portable electrically operated die-stock for threading 3/8-, 1/2-, and 3/4-inch pipe has been developed by the Oster Mfg. Co., Cleveland, Ohio. This die-stock is driven by a fully enclosed universal motor which operates from any lamp socket on either direct or alternating current of 110 volts. The housing, which covers the gear reduction from the motor to the die-head, is made of an aluminum alloy, with the result that the weight of the tool is less than 35 pounds.

In operation, the tool is placed on the end of a stationary piece of pipe in exactly the same manner as though the operator were going to thread the pipe by hand. It is centered by means of a universal chuck, and can be placed on the pipe without first filing off burrs. A



Oster Portable Motor-driven Die-stock

separate die-head is furnished for each size of pipe. The change to suit a different size of pipe is quickly made by simply pulling out a pawl which holds the die-head to the rotating sleeve, thus disengaging the head from the sleeve and allowing another to be inserted in place.

Although there is a different die-head for each pipe size, the dies are fully adjustable, so that over-size and under-size threads can be cut as easily as standard threads. The switch is conveniently located at the top of the tool under the fingers of the operator. A quarter turn of the switch is sufficient to start rotating the die-head to cut the thread. Another quarter turn stops the motor, while still a further quarter turn reverses the motor to back the dies off the thread.

* * *

PERSONALS

Francis G. Eppley, for many years superintendent of the Albaugh-Dover Mfg. Co., Chicago, Ill., was elected a director at the recent annual meeting of stockholders.

W. L. Schellenbach, engineer, has moved his office to 611-612 Second National Bank Bldg., 9th and Main Sts., Cincinnati, Ohio, where better facilities are provided for his work.

C. S. Seltzer, formerly mechanical engineer with the American Can Co., Newark, N. J., has become chief engineer of the Anchor Post Iron Works located at Garwood, N. J., and Cleveland, Ohio.

V. A. Root, who for the last four and one-half years has been with the National Automatic Tool Co., Richmond, Ind., as assistant sales manager, is now associated with the W. F. & John Barnes Co. of Rockford, Ill.

Nelson Brandt has rejoined the sales management force of the Link-Belt Co., Chicago, Ill., and has been placed in charge of a new branch office which is to be opened up in Florida in the vicinity of Jacksonville or Orlando.

Maurice R. Hart, who has been connected with the Morse Chain Co., Ithaca, N. Y., for several years in the production department, and for the last two years in the sales department, has been appointed manager of the Buffalo district, with headquarters at the Ellicott Square Bldg., Buffalo, N. Y.

T. R. Sanders, 180 Milk St., Boston, Mass., has been appointed district representative for the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill. Mr. Sanders' territory will include Rhode Island and the eastern half of Massachusetts.

E. O. Shreve, manager of the San Francisco office of the General Electric Co. since 1918, has been made manager of the industrial department of the company with headquarters at Schenectady, N. Y., filling the vacancy caused by the death of A. R. Bush.

Oskar Kylin has entered the service of the Lucas Machine Tool Co., Cleveland, Ohio. Mr. Kylin has for ten years been connected with the Foster Machine Co., Elkhart, Ind., during the last few years having been vice-president in charge of engineering and sales.

W. R. Milnor and W. C. Darugh have been added to the sales organization of H. H. Snell, Philadelphia district representative for Foote Bros. Gear & Machine Co., Chicago, Ill. Mr. Milnor and Mr. Darugh will devote their efforts to the sale of IXL speed reducers and industrial gears.

P. E. Floyd has been appointed manager of sales in charge of the Chicago office and warehouse of the Ludlum Steel Co. of Watervliet, N. Y., manufacturer of tool steels and non-corrosive steels. Mr. Floyd succeeds Mr. Edwards, who has been transferred to the southern territory, with headquarters at Houston, Tex.

Howard B. Jernee has been made sales manager of the lineshaft bearing department of the Hyatt Roller Bearing Co., Newark, N. J., succeeding Frank S. Cole. Mr. Jernee was formerly construction engineer for E. I. du Pont de Nemours & Co., and later works engineer at the Oakland Motor Car Co.'s plant in Pontiac, Mich.

Leo A. Dumser has become connected with the Kearney & Trecker Corporation, Milwaukee, Wis., in the capacity of sales engineer. Mr. Dumser will specialize in following up inquiries and sales for the production service department. He was formerly Wisconsin representative for the Barber-Colman Co. and sales engineer for the Western Iron Stores Co. of Milwaukee.

E. M. Hummer, vice-president and general manager of the Defiance Machine Works, Defiance, Ohio, sailed from New York on April 14 on the *Aquitania* for Great Britain and the Continent. Mr. Hummer expects to visit France, Belgium, Germany, and Holland for the purpose of renewing sales representation of the Defiance Machine Works' lines of metal-working and woodworking machines.

Frank H. Colladay has been appointed district sales manager of the Braeburn Alloy Steel Corporation, Braeburn, Pa., in charge of the New York district. Mr. Colladay was formerly New York manager of sales of the Trumbull Steel Co., and he has been connected with the steel industry all his life. He will make his headquarters at the New York sales offices, which are located in the Grand Central Terminal Bldg.

Harlan A. Pratt has been appointed manager of the oil and gas engine department of the Ingersoll-Rand Co., 11 Broadway, New York City. Mr. Pratt was connected for many years with the sales department of the Westinghouse Electric & Mfg. Co., later becoming sales manager of the Atlantic Elevator Co., agent for Westinghouse gearless traction elevators. For the last three years he has been sales manager of the Elevator Supplies Co., Hoboken, N. J.

J. W. Marks, president and general manager of the Auto Products Corporation, Jackson, Mich., has resigned because of illness. C. H. Peterson will take Mr. Marks' place as general manager, and has also been appointed secretary and treasurer. The other officers are W. R. Morgan, president, and L. R. Welcome, vice-president. The company is contemplating an expansion of its present building and the addition of extra equipment.

Horace A. Frommelt, formerly assistant works manager of the Falk Corporation, Milwaukee, Wis., has become associated with the International Correspondence Schools of Scranton, Pa., as consultant of the apprentice training division, and will give his full time to the inauguration and development of apprentice training programs. Mr. Frommelt has had wide experience along this line, and has spoken and written on the subject a great deal during the last three years.

T. J. Pace, formerly manager of the supply department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed director of sales of the company. In 1899 Mr. Pace became connected with the Manhattan General Construction Co. of Newark, N. J., which, at that time, was owned by George Westinghouse. In 1902 when this company was purchased by the Westinghouse Electric & Mfg. Co., Mr. Pace moved to East Pittsburg, where, after holding various positions, he became, in 1922, manager of the supply department.

C. R. Rosborough, formerly secretary of Williams, White & Co., Moline, Ill., has become connected with the Moline Tool Co., also of Moline, Ill., in the same capacity. Mr. Rosborough has been with Williams, White & Co. for twenty-six years, having been actively identified with the sales department of this company, and still will remain one of the directors. The increasing demand for the product of the Moline Tool Co., known as the "Hole Hog" line, is requiring more of the time of W. P. Hunt, president of the company, for the further development of this line of machinery, and Mr. Rosborough will relieve him of some of the duties he has carried up to the present time. Mr. Rosborough is a member of the American Society of Mechanical Engineers.

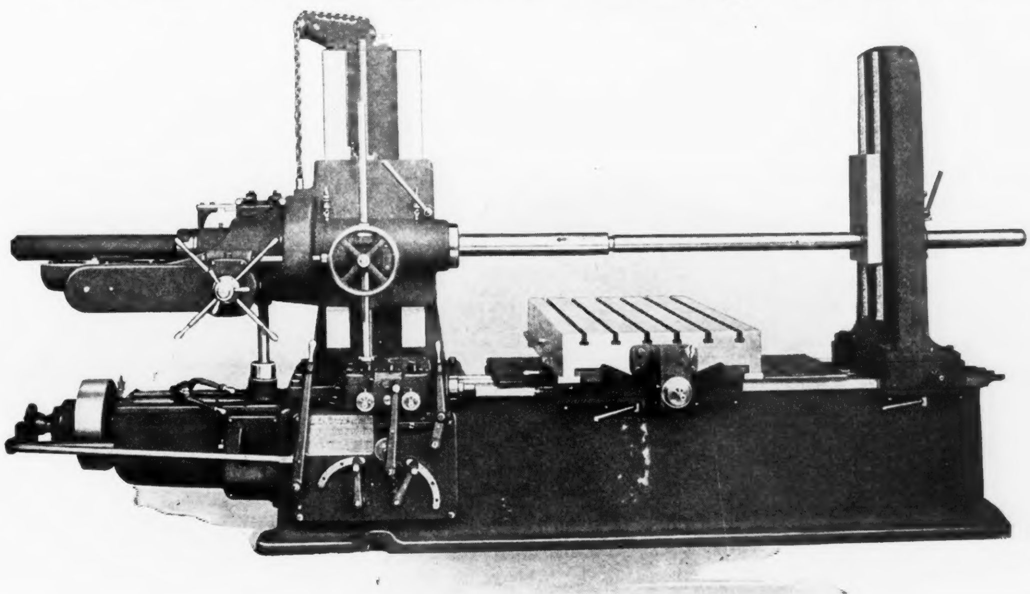
E. H. Sniffin, formerly manager of the power department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed assistant to the vice-president and general sales manager. Mr. Sniffin was at one time commercial aid to George Westinghouse, founder of the Westinghouse companies. He is one of the three men who were directly responsible for the introduction of the steam turbine in the United States. He has been with the company since he was sixteen years old. In 1900 he was made sales manager of the Westinghouse, Church, Kerr & Co., and three years later was appointed sales manager of the Westinghouse Machine Co. In 1915 when the Westinghouse Electric & Mfg. Co. absorbed this concern, he was made manager of the power sales department.

An Excellent Overflow Machine

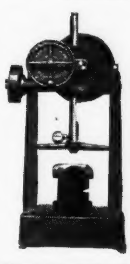
As your boring, milling and drilling departments become crowded, from time to time, take care of the peak load in all of them, successively and successfully with a LUCAS

"PRECISION"

Boring, Drilling and Milling Machine



Holes may be bored and surfaces milled at a single setting and their accurate relation assured, without the necessity of expensive jigs.



WE ALSO MAKE THE

LUCAS POWER

Forcing Press

If you attend the Railway Supply Manufacturers' Association Exhibition at Atlantic City, June 9th to 16th, be sure to look up our exhibit of both machines in spaces 843 and 845, Machinery Hall, across the Boardwalk from the Pier.

THE LUCAS MACHINE TOOL CO., Cleveland, Ohio, U. S. A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo. Ing. M. Kocian & G. Nedela, Prague.

TRADE NOTES

Commerce Pattern Foundry & Machine Co., 2211 Grand River Ave., Detroit, Mich., has recently expanded its plant, adding to its tool-room a complete line of milling machines.

Waterloo Gasoline Engine Co., Waterloo, Iowa, which has been owned and operated by Deere & Co. of Moline, Ill., since March, 1918, has been given the name John Deere Tractor Co.

Grobet File Corporation of America, a branch of the Grobet File Co. of Vallorbe, Switzerland, has moved its offices from 64 Reade St. to 3 Park Place, New York City, opposite the Woolworth Building.

Threadwell Tool Co., formerly located at 66 Baltimore Ave., Detroit, Mich., has just moved into new quarters at 1323 Dime Bank Building, Detroit. A. T. Ritchie is sales engineer and George S. Gardner, district manager.

Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, has acquired the George Oldham & Sons Co. of Baltimore, Md. The manufacture of the Oldham products will be conducted at the Detroit plant, 6201 Second Blvd.

Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., have made arrangements with F. A. Brandes of the Brandes Machinery Co., Keith Bldg., Cleveland, Ohio, to serve as exclusive representative for the complete line of Ryerson metal-working machinery and small tools.

Boye & Emmes Machine Tool Co., 2245 Spring Grove Ave., Cincinnati, Ohio, states that the work of rebuilding the company's plant is progressing at a satisfactory rate, and its completion is looked forward to within the near future. In the meantime, arrangements are being made so that manufacture can be started as soon as the new building is ready.

Watson-Stillman Co., designer and builder of hydraulic machinery and equipment, announces that on and after May 1 its main offices and sales department will be located in the Evening Post Building, 75 West St., New York City. The company has also established a sales office at 7752 Duboise St., Detroit, Mich., with Earle M. Porter as manager.

American Engineering & Sales Corporation has been organized at 1317 F St., N. W., Washington, D. C., to render consulting engineering service, including investigations and reports on manufacturing methods, management, patents, and commercial and legal matters. Walter N. Polakov is president; Wallace Clark, vice-president and secretary; and I. B. Richman, treasurer.

Tomkins-Johnson Co., Jackson, Mich., manufacturer of tools, dies, and die-sinking milling cutters, is now located in new quarters at 617 N. Mechanic St., Jackson. New equipment, including lathes, milling machines, and grinders, has been installed, and the size of the hardening plant has been increased. The company has taken over the manufacture of the Hopkins air chucks, cylinders, and valves.

Henry Disston & Sons, Inc., Philadelphia, Pa., have announced the development of a new high-speed steel combining hardness and toughness to an unusual degree. This steel is being used in the Disston A-1 machine knives, intended for work that requires a cutting edge that will retain its sharpness and at the same time stand up under hard service. It is also being used in the Disston "Lock-Weld" inlaid knife, in which a section of the high-speed steel is inlaid in a carbon steel back.

Northern Engineering Works, Detroit, Mich., manufacturers of electric traveling cranes, hoists, and foundry equipment, have made an extensive development in their foundry department due to the increasing demand for foundry equipment. The facilities of the foundry department have been extended and the selling connections have been increased. Aside from the company's district offices, which are maintained in all large cities, extensive representation has been established at central points throughout the country.

Simonds Saw & Steel Co., Fitchburg, Mass., announces that Alvan T. Simonds, president of the company, will award this year, as usual, prizes in a contest for the purpose of advancing the study of economics. Three awards, amounting to $1500, are to be made, and this year the contest is open to anyone who wishes to compete. The subject for the contesting treatises is "Saving and Spending as Factors in Prosperity." For further information, address Contest Editor, Simonds Saw & Steel Co., 470 Main St., Fitchburg, Mass.

Cisco Machine Tool Co., Inc., Cincinnati, Ohio, recently purchased the Mueller Machine Tool Co. of Cincinnati, manufacturer of radial drills and lathes. The Cisco Machine Tool Co. will not manufacture the Mueller line of lathes, but will furnish repair parts and attachments for these lathes. However, the company will continue to manufacture the full line of Mueller radial drilling machines, in sizes from 2 to 4 1/2 feet, and will furnish repair parts for the drilling machines, that have already been sold. The name Mueller will be retained to designate these machines.

OBITUARY

Alexander Blaser, a welding and cutting expert with the Air Reduction Sales Co., of New York, died at his home in Union City, N. J. on March 24, after a long illness, aged forty-one years. Mr. Blaser was born in Switzerland, and came to the United States at the age of twelve with his parents, who settled in St. Louis, Mo. He learned the coppersmith's trade, and in the practice of his trade, went to Jersey City, where he was employed by the Davis-Bournonville Co. in 1910. He became an expert torch operator of unusual ability, and was a well-known figure at convention exhibits where the Airco-Davis-Bournonville oxy-acetylene cutting machines were demonstrated.

MACHINE TOOL EXHIBIT IN DAYTON

An exhibition of machine tools in operation on actual shop work is to be held on May 3 to 15 at the store-rooms of the Seifreat-Elstad Machinery Co., 20-22 S. Canal St., Dayton, Ohio. The exhibition will be open each day from nine o'clock in the morning until five o'clock in the afternoon, and from seven to ten in the evening. The company is holding this exhibition as a convenience to its customers who in the past have often had to visit distant points for the purpose of studying equipment and methods. Among the machines to be shown are radial drilling machines, lathes, shapers, drilling and tapping machines, die-sinking machines, portable electric tools, screw machines, thread milling machines, turret lathes, milling machines, broaching machines, filing machines, belt sanders and grinders, punching and shearing machines, polishing machines, spring presses, and grinders.

COMING EVENTS

MAY 3-6—Regional meeting of the American Society of Mechanical Engineers at Providence, R. I. Luther D. Burlingame, Brown & Sharpe Mfg. Co., Providence, R. I., chairman of the local committee. Calvin W. Rice, 29 W. 39th St., New York City, secretary of the society.

MAY 13-15—Annual meeting of the American Gear Manufacturers' Association in Detroit, Mich. Headquarters, Book-Cadillac Hotel; secretary, T. W. Owen, 2443 Prospect St., Cleveland, Ohio.

JUNE 1-4—Semi-annual meeting of the Society of Automotive Engineers at French Lick Springs, Ind. Coker F. Clarkson, 29 W. 39th St., New York City, secretary.

JUNE 9-16—Convention and exhibit of the Mechanical Division, American Railway Association, Young Million Dollar Pier, Atlantic City, N. J. Secretary of the Mechanical Division: V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill. Secretary-treasurer of the exhibit: J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

JUNE 16-18—Thirteenth national convention of the Society of Industrial Engineers to be held at the Bellevue-Stratford Hotel, Philadelphia, Pa. The keynote of the convention will be "Practical Methods for Eliminating Waste." George C. Dent, executive secretary, 608 S. Dearborn St., Chicago, Ill.

JUNE 21-25—Twenty-ninth annual meeting of the American Society for Testing Materials at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. Secretary's address, 1315 Spruce St., Philadelphia, Pa.

JUNE 28-JULY 1—Spring meeting of the American Society of Mechanical Engineers at San Francisco, Cal. Warren H. McBryde, California & Hawaiian Sugar Refining Corporation, 215 Market St., San Francisco, Cal., chairman of the local committee. Calvin W. Rice, 29 W. 39th St., New York City, secretary of the society.

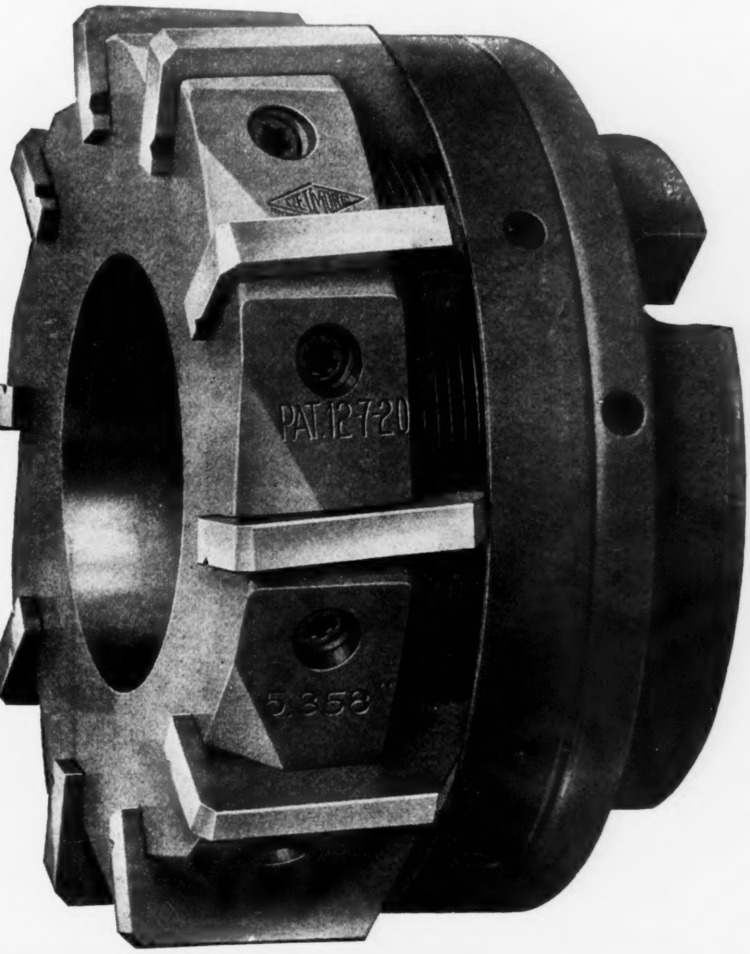
JULY 1-SEPTEMBER 15—International Exhibition for Inland Navigation and Utilization of Hydraulic Power, at Basle, Switzerland. For further information apply to Organizing Secretary, International Exhibition, Basle V, Switzerland, or to the Swiss Federal Railroads, 241 Fifth Ave., New York City.

SEPTEMBER 20-24—Eighth annual convention and exposition of the American Society for Steel Treating to be held at the Municipal Pier, Chicago, Ill. W. H. Eisenman, secretary, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 27-OCTOBER 2—Annual convention of the American Foundrymen's Association and second international foundry congress in Detroit, Mich. In conjunction with these conventions there will be held an international exposition of foundry and machine shop equipment and supplies. C. E. Hoyt, secretary-treasurer, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 2-10—Southern exposition to be held in the New Madison Square Garden, Eighth Ave. and 49th St., New York City. W. G. Sirrine, president of the exposition, New Madison Square Garden, New York City.

A distinctive feature of this Wetmore Shell Reamer is the 1/8" projection of the blades over the end of the reamer body for chip clearance. This allows the chips to fall off ahead of the reamer body and prevents chips from clogging up along cutting edge of blades.

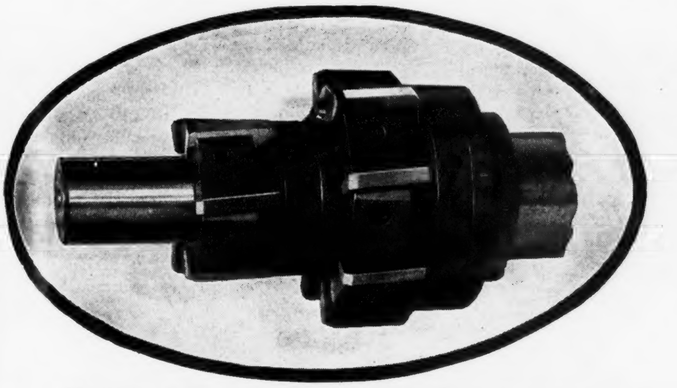


Wetmore Shell Reamers have .087" adjustment oversize. Made in these sizes: 1¼" to 3", 6 blades; 3-1/16" to 5", 8 blades; 5-1/16" to 6", 10 blades. Larger sizes made on order. Made also with straight hole, if desired. Sizes above 1¾" readily adaptable for line reaming.

Why Big Plants Specify WETMORE Shell Reamers

More than one user has told us that Wetmore Shell Reamers have done work they thought would be too much for any reamer.

But Wetmore Reamers have the habit of making good on hard jobs. We guarantee them to lower your production costs. They do faster work; they stand up longer; blade replacement costs are lower.



Above is shown how Wetmore Shell Reamers can be adapted for pilot reaming in combination or single.

Wetmore Shell Reamers are adaptable for either line or pilot reaming. Body, lock nut, and cone nut are finest alloy steel, heat-treated. Left-hand angle blades are staggered to eliminate chattering.

Send for Catalog No. 26

—showing the full line of Wetmore adjustable reamers, and reduced prices. Sent free—postpaid.

WETMORE REAMER CO.

60-27th St., Milwaukee, Wis.

WETMORE ADJUSTABLE REAMERS

"THE BETTER REAMER"

NEW BOOKS AND PAMPHLETS

WATTHOUR METER ACCURACY AS AFFECTED BY TEMPERATURE CHANGES. By D. T. Canfield. 19 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 22 of the Engineering Experiment Station.

COMPARATIVE ACCURACY OF THREE-PHASE, FOUR-WIRE METERING METHODS. By D. T. Canfield, 15 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 13 of the Engineering Extension Department.

VIBRATION IN ENGINEERING. By Julius Frith and Frederick Buckingham. 123 pages, 5½ by 8½ inches. Published by MacDonald & Evans, 8 John St., Bedford Row, W.C. 1, London, England. Price, 7/6.

The question of vibration is of vital importance to both the manufacturer and user of machinery, and yet the literature on this subject is very scarce. The reason for this is that a proper understanding of the subject involves diverse problems in sound, strength of materials, and mechanics, as well as the physics and mathematics of harmonic motion. The purpose of the present book is to bring together and coordinate these different aspects, and to present the subject of engineering vibration as a unit, first from the physical and then from the mathematical standpoint. The book discusses the causes of vibration and methods of detecting and eliminating them.

NEW CATALOGUES AND CIRCULARS

SAWS. Ohlen-Bishop Co., Columbus, Ohio. Catalogue 7, covering the complete line of hand-made saws manufactured by this company.

OAKITE. Oakley Chemical Co., 26 Thames St., New York City. Circular containing revised prices for Oakite cleaning compound.

MICROMETERS. Brown & Sharpe Mfg. Co., Providence, R. I. Circular descriptive of the new B & S No. 26 direct-reading micrometer.

OXYGEN FOR METAL CUTTING. Air Reduction Sales Co., 342 Madison Ave., New York City. Circular treating of the subject of oxygen purity and cutting efficiency.

ELECTRIC FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Folder 39, and Bulletins 2075 and 2089, descriptive of condulets for grounding service wire and conduit systems.

BALL BEARINGS. Norma-Hoffmann Bearings Corporation, Stamford, Conn. Pamphlet descriptive of the application of Norma ball bearings in fractional horsepower motors.

WIRE FORMING MACHINES. Baird Machine Co., Bridgeport, Conn. Circular illustrating Baird spring making machines, wire forming machines, tumblers, and burnishing and japanning barrels.

INDUSTRIAL TRUCKS. Clark Tructractor Co., Buchanan, Mich. Booklet entitled "Clark Theory of Labor Economy," dealing with the subject of mechanical transportation of materials during the process of production.

TWIST DRILLS AND REAMERS. Whitman & Barnes Mfg. Co., Akron, Ohio. Circular illustrating the use of W & B twist drills and reamers in the production of automobile tire rims at the plant of the Firestone Steel Products Co.

STRAIGHTENING MACHINES. Kane & Roach, Syracuse, N. Y. Bulletins 52, 53, 57, and 58 (bound in loose-leaf folder), illustrating and describing the line of straightening machines made by this concern. Bulletin 57 contains a list of users.

MILLING MACHINES. Ingersoll Milling Machine Co., Rockford, Ill. Folder descriptive of what is said to be the largest milling machine ever built in this country, which has a capacity for milling a casting 10 feet wide, 8 feet high, and 36 feet long.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Sheets for loose-leaf catalogue, containing dimensional and capacity data, price list, and telegraph code for double-row, single-row, "Radax," magneto, and automobile front-wheel ball bearings.

REAMERS. Wetmore Reamer Co., 60 27th St., Milwaukee, Wis. Catalogue 26, covering the Wetmore line of adjustable reamers. Two new types of reamers that have been added to the line are described in the catalogue, and several price reductions are listed.

DRILLING MACHINES. Edlund Machinery Co., Inc., Cortland, N. Y. Catalogue of Edlund sensitive drilling machines, containing illustrations and specifications covering the various sizes and styles, including both single-spindle and multiple-spindle machines.

WELDING AND CUTTING EQUIPMENT. International Oxygen Co., Newark, N. J. Bulletin listing International welding and cutting apparatus, including torches and regulators. Separate price lists are issued covering welding and cutting apparatus and accessories.

CRANKSHAFT LATHES. Wickes Bros., Saginaw, Mich. Bulletin CS-1, illustrating and describing in detail the Wickes 34-inch semi-automatic crankshaft lathe, which is made in both duplex and universal types. A number of illustrations of various tooling lay-outs are shown.

TRAFFIC SAFETY MARKERS. Bridgeport Brass Co., Bridgeport, Conn. Pamphlet entitled "Pointing the Way to Safety and Economy," descriptive of Bridgeport traffic spots, which are brass cups used for marking traffic divisional lines both on highways and in industrial plants.

FLEXIBLE SHAFTS AND EQUIPMENTS. N. A. Strand & Co., 5001-5009 N. Lincoln St., Chicago, Ill. Booklet B, containing illustrations and specifications covering the Strand line of flexible shafts and flexible-shaft grinding and polishing machines, screwdrivers, nut-setters, and rotary files.

DIE-HEADS. Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn. Wall chart containing data on the design and manufacture of threaded parts. The chart gives tables of all standard thread sizes, as well as information on depth of thread, tap drill sizes, etc.

NOISELESS GEARS. Formica Insulation Co., Cincinnati, Ohio. Pamphlet containing data and instructions relating to the use of Formica gears. The pamphlet describes the physical and mechanical properties, and gives instructions for drilling, reaming, turning, cutting the teeth, etc.

RESISTANCE THERMOMETERS. Brown Instrument Co., 4562 Wayne Ave., Philadelphia, Pa. Catalogue 92, descriptive of the Brown line of resistance thermometers for measuring temperatures from — 300 degrees to + 1000 degrees F. Prices of the thermometers are included.

TRUCKS AND TRACTORS. Lansing Co., Lansing, Mich. Catalogue 12, covering the general line of products made by this concern, which includes concrete mixers, hoists, wheelbarrows, warehouse trucks, steel scrapers, hand carts, fence machines, hods, wheels, skids, electric tractors, trailer trucks, etc.

STEEL RIVETED PRODUCTS. Kewanee Boiler Co., Kewanee, Ill. Circular entitled "Steel Plus Rivets Equals Strength," showing examples of applications of steel riveted products in various fields, including shipbuilding, bridge-building, manufacture of locomotives, constructional engineering, boiler making, etc.

BALL BEARINGS. Torrington Co., 57 Field St., Torrington, Conn. Catalogue and price list of Torrington ball bearings of the magneto and radial types. A full-size scale drawing of all the different sizes of Torrington ball bearings is included, for the convenience of designers and engineers.

MACHINE TOOLS. Jones Machine Tool Works, Inc., Philadelphia, Pa. Loose-leaf catalogue containing illustrations and specifications covering slotting machines, horizontal boring, milling, and drilling machines, vertical boring and turning mills, horizontal boring and drilling machines, and arbor and straightening presses.

NOISELESS GEARS. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue containing detailed information on "Micarta" gears and pinions, including data on the physical properties and correct method of installing; instructions for performing various machining operations on these gears; and tables of horse-power ratings.

COUNTERBORE SETS. Gairing Tool Co., Detroit, Mich. Circular illustrating and describing Gairing counterbore and spot-facing sets, consisting of different sizes of tools, pilots, and holders. The two styles of sets that are made—type B having a ball drive bayonet socket and type A having a rigid hexagon drive—are illustrated.

ELECTRIC EQUIPMENT. General Electric Co., Schenectady, N. Y. Catalogue GEA-232 entitled, "Power Factor and Means for its Improvement," containing a treatise on the means for power factor improvement in industrial plants. Bulletin GEA-352 devoted to capacitors for correcting the power factor on electric transmission lines.

BAROMETER AND VACUUM RECORDER FOR STEAM TURBINES. Uehling Instrument Co., 473 Getty Ave., Paterson, N. J. Bulletin 150, descriptive of a combined barometer and vacuum recorder for use with steam turbines. The bulletin also contains turbine performance data, typical charts, sectional views and dimension diagrams, etc.

AUTOMOBILE TOOLS. Alvord-Polk Tool Co., Millersburg, Pa. Catalogue 7A, entitled "Alvord System for Ordering Tools," containing data required for ordering automobile tools, including piston-pins, valve guides, valve seats, and connecting-rod reamers for all makes of cars. The catalogue also contains illustrations and prices covering the tools most frequently used in automobile repair work.

JIG BORING MACHINES. Societe Genevoise d'Instruments de Physique, Geneva, Switzerland, (United States representative, R. Y. Ferner Co., Investment Building, Washington, D. C.). Pamphlet 414, entitled "The Economical and Accurate Production of Jigs and Fixtures." The pamphlet describes the jig boring machine made by this concern—the details of construction, use, standard types, and upkeep.

WORM-GEARING. David Brown & Sons (Hudd.) Ltd., Lockwood, Huddersfield, England. Bulletin on worm-gearing, containing a complete treatise on the design, manufacture and application of worm-gearing and worm reducing gear units. This booklet comprises more than a mere catalogue, containing considerable technical information on the design of worm-gears based on investigations made by the technical and research staff of this company.

VARIABLE - SPEED TRANSMISSION. Reeves Pulley Co., Columbus, Ind. Catalogue T-66, descriptive of the Reeves variable-speed transmission. Among the new features to which particular attention is called are the improved split splice block for the V-belt, the force feed system of lubrication, electrical and mechanical remote control, and the vertical design transmission. The catalogue also contains a table arranged to facilitate the selection of the proper size and class of Reeves transmission for a given service when driven from a motor.

TURRET LATHE TOOLS. Warner & Swasey Co., Cleveland, Ohio. Catalogue 21, covering the complete line of turret lathe tools made by this company. The catalogue contains descriptions of 161 tools and over 100 method sketches showing how the tools may be used, as well as 32 pages of dimension drawings intended to aid engineers, time-study men, etc., in laying out tools on the board without fear of tool interference. The book is conveniently thumb-indexed, the different sections covering chucking tools; bar tools; cross-slide tools; holding devices; dimension drawings; turret lathes; speed and feed charts, and other useful tables, and index.